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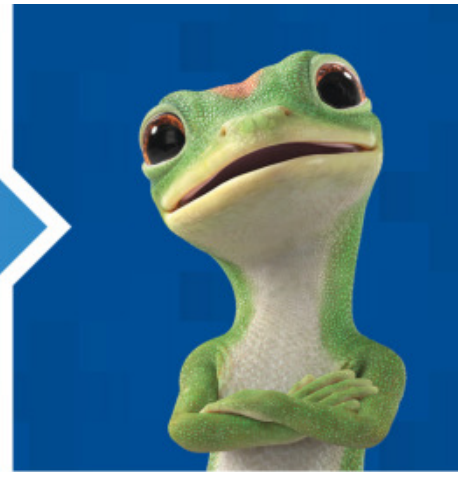

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Backfires

The joyful noise of the commentariat, rebutted sporadically by Ed.

WINGED

Regarding "The Last Shift" [April 2021]: What a shift indeed! You say the Cadillac CT5-V Blackwing is "a veritable four-door Corvette." I say nay, nay. The Caddies can be equipped with six-speed manuals, while the new C8 is automatic only. The world has shifted indeed.

–Kevin Parsons
Meridian, ID

I love driving a manual, but the Cadillac Blackwing story refuses to accept that automatics have gotten so good that one should not feel ashamed of getting an automatic in a car like that. A reasonable case could be made that this is too much car for a manual. The manuals' only hope is in fun little cars—which also are dropping like flies (no more Fiesta ST)—and maybe the Wrangler. The Miata is likely going to be the Alamo for the manual, so if you want to save the manual, forget about everything else and encourage people to buy a Miata.

–Craig Schroll
Danville, PA

I own a Dodge Challenger SRT Hellcat with a six-speed manual. I was longing for a Charger SRT Hellcat Redeye Widebody, but I didn't want an automatic. Sorry, Dodge—at a similar price, the manual CT5-V Blackwing, a vastly better all-around performer, is now my choice.

–Harv Apotheker
Templeton, MA

That's just what an old Florida driver needs: a 668-hp 200-mph Cadillac. Insane car for our times.

–Clyde Romero
Marietta, GA

TOY STORY

Wow, eight pages wasted on motorized toys ["Quarantine Toys," April 2021]. Meanwhile, "The French Connection" notes several marques and dozens of vehicles you could review. Don't blame it on COVID-19. This one's on you.

–S. Mark Bogdanik
Gowen, MI

Nothing says "I don't give a sh*t about other people at the lake" like owning and operating personal watercraft. Thankfully, they are banned at the lake I visit once a year. In anticipation of Ed.'s response, I don't mind if the kids play on my lawn.

–Jeff Hamilton
Winnipeg, MB

GENTLEMAN BRONCOS

In "Split Personality" [April 2021], the specs say the Jeep Cherokee will lose the mpg race, but it should've won the fuel-economy category due to using regular gasoline, versus pre-

APRIL MARTIN

You know, I knew it was BS that your caption about the new Aston Martin DBX suggested I scratch the paper to smell the interior ["Iceberg, Right Ahead!" April 2021]. And yet I could not help myself. And the funny thing is, I didn't even feel stupid doing it!

–Aladino Debert
Los Angeles, CA

The Aston Martin DBX's interior smells like a magazine page. Not sure about "rich," but it's not a bad smell.

–J. Bednarz
Middlesex County, NJ

On page 33, there was a shot of the interior of the new Aston Martin SUV with an invitation to scratch the photo to see how it smells. I scratched it. The interior of the Aston Martin SUV smells like paper and ink.

–Russell Myers
Grants Pass, OR

Y'all ever see a Russ Meyer film?–Ed.

Bet I'm not the only moron who scratched the picture.

–Tom Page
Winchester, OR

I scratched
I sniffed
I got no whiffs
What gives?

–Dan Steinhilber
Winnipeg, MB

I've been instructed not to write a COVID-19 joke–Ed.

How many readers besides myself, despite having full awareness that your suggestion was parodic, admitted to tearing page 33 of your April issue while attempting to scratch and sniff the photo of the sumptuous leather interior in the new Aston Martin DBX?

–Dan Kirby
San Jose, CA

Backfires

Was the Jeep's 17 mpg actually better than the Ford's 20 mpg or the Mazda's 21 mpg? No.

mium for the Ford Bronco Sport and Mazda CX-5.

–Dick Schimelfenyg
Cape Coral, FL

Our specs show a manufacturer's recommended fuel, but both the Ford and the Mazda will run safely on regular gas. The Mazda's output drops to 227 horsepower on 87 octane (versus 250 on 93). Ford says the Bronco Sport makes 250 horsepower with premium gas, but doesn't specify how much power it makes on regular–Ed.

It's finally happened. After 60 years, I've become such a loser that I'm writing a letter to a car magazine. [*This is how you start a letter–Ed.*] I know it's not part of the game, but when you go to the Mazda store, you basically pay the list price. I can buy a Cherokee Trailhawk in the current model year for $9000 or even $9500 under sticker.

–Steve Johnson
Redondo Beach, CA

LIKE A G70

Your long-term tests have often been a key decider in vehicle purchases for me, and the one on the Genesis G70 in the April issue pulled me in. The prospective joy of spending hours of my life at the wheel of a relatively lightweight rear-wheel-drive sedan sent my hopes soaring! Then I plunged into the Genesis website in search of a car. All I found within a 100-mile radius of my home were all-wheel-drive versions with four-cylinders. The two dealers I reached out to said, "Why would you want rear-drive? It snows around here."

Please inform your readers that finding a rear-drive sweetheart like the G70 in the land of ice and snow is a fantasy that will require great persistence.

–Chris Flynn
Allentown, PA

Well we're shopping here in Allentown
But they're selling only all-wheel drives
And the rear-wheel drives don't come this way
Dealers are lame
Buyers be brave
–Eddy Joel

As a previous owner of a first-year Infiniti G35S and now a G37S, I can say that Genesis reminds me of everything Infiniti once was but now inexplicably chooses not to be.

–Erich Schroeder
Katy, TX

Is the G70 depreciation figure correct? Over 50 percent drop in year one, from $45K to $22K? Why would you buy one new?

–Nikita
Phoenix, AZ

It was correct up until used-car prices spiked–Ed.

SHIPPETAY

Kudos to Andrew Lawrence for floating "Ship Happens" [April 2021]. Much more intriguing than how to navigate a dirt-bike wheelie.

–Don Rinker
Castro Valley, CA

DOUBLE VISION

I don't see what all the fuss is regarding the retro vertical kidney grilles on the new M3 ["Drift Analyzer," April 2021]. I think they're cool, but then, my weekend driver is a '99 Plymouth Prowler. Too cool for school! Sorry, am I banned from future Backfires?

–Gary Keen
Ponte Vedra Beach, FL

Only if your Prowler has the matching trailer–Ed.

You guys really got me with this year's April Fools' joke on page 69. Funny. Then I saw one driving on the street, and now I realize that was not your doing but BMW's.

–Chris Lalock
Angola, NY

In the April issue, there are two BMWs in the Rundown section: an M3 and an M2 CS ["Hang in There"]. How is an M3 nearly $15,000 less than an M2? Is there something in the CS that justifies such a steep markup over the M3? Not to mention the as-tested price of the M2, which, to my mind, goes way beyond what that car should be able to command.

–Charles S. Geraty-Branch
Johnstown, NY

The M2 CS will be sold in very limited numbers, and we hear that opportunistic dealers are actually selling them for more than the MSRP–Ed.

VAN MAN

So I read "Minivan Man," Ezra Dyer's column from the April issue about his Pacifica. It says, "The Hybrid's electric motors make 231 and 92 pound-feet of torque." So that's like, what, 329 pound-feet? Why are you making me do math? Who edits these things? I'd ask you to cancel my subscription, but you guys will probably f*ck that up too.

–Aleks Zawisza
Ottawa, ON

The Pacifica Hybrid employs a two-motor, power-split transaxle. Each motor has its own torque peak, and while in theory they could produce a combined output that's the sum of the two (i.e., 323 pound-feet, not 329), that wouldn't be good for components downstream. Chrysler doesn't provide a combined torque number because it would be theoretical, so here we are–Ed.

"We went with the hybrid because the Pacifica's 32 miles of electric range are more than enough for our usual daily driving, and its smooth and silent EV behavior complements the minivan's luxurious mien." I'm going to get right to it: Who are you, sir, and where should we send the authorities to retrieve Dyer's body?

–Nick V.
Silver Spring, MD

CHARGING AHEAD

"Phoenix Rising," Elana Scherr's column on the origin of the turbo 301 Pontiac Trans Am, was excellent [April 2021]. It was a story I hadn't heard anywhere else, she interviewed key players who deserved wider

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recognition, and her telling was a riot! Material like this is why *Car and Driver* entertains like nothing else.

–Michael Cosgrove
Lexington Park, MD

Loved Scherr's story of the early-'80s T/A, but of all the cars that one would actually own, why? This car is the ultimate symbol of the epic decline of GM. It's heavy and bloated, with poor steering and a lousy suspension, not to mention the awful engine that the "dead-ass" engineers at GM designed. This car was an early indication that a GM bankruptcy was inevitable, and I'm surprised that anyone at GM would admit to working on it. Scherr, really? You like this car?

–Larry Angelilli
Dallas, TX

SUSPENDERS

Wow. The Porsche 911 GT3 gets a new track-focused front suspension with unequal-length control arms–a milestone upgrade ["Tracking Progress," April 2021]. This kind of suspension design was used on that bastion of chassis innovation, the Chevrolet Chevette. This technology apparently helped sell 2.8 million of these incredible machines to hardcore enthusiasts in the U.S. Maybe Porsche should advertise that it's using Chevette-based front-suspension technology to help boost GT3 sales.

–Gregory E. Peterson
Sylvan Lake, MI

Yeah, and Chevrolet missed an opportunity to advertise that every Corvette from 1963 to 2019 had transverse leaf springs that were Model T–shared technology–Ed.

STELLA, STELLA!

After reading "The Chrysler Brand Cull Is Coming" in the April issue, I kept coming back to that name: Stellantis. In my head, it sounds like a long-deceased Chrysler minivan or maybe a station wagon. And then I thought, is that just because of the simple correlation between Pacifica (Pacific) and Stellantis (Atlantic)? Oceans of questions to be answered with that merger.

–John Park
Tempe, AZ

Kudos to Lawrence Ulrich for his article on the new Stellantis empire. It was informative, entertaining, and succinct.

–Jon Campbell
Carlsbad, CA

ENDERS

With destination charges now exceeding $1000, I suggest you add this nonnegotiable cost to your vehicle data.

–Doug Robie
Morganton, NC

The base prices we list include destination and other inescapable charges such as a gas-guzzler tax–Ed.

I always get a good chuckle out of Backfires comments by Ed. He seems to have the right mixture of candid truth while mixing it with a proper twist of fun. So is Ed. a real-life grumpy person, or are the rebuts spit out by an AI computer?

–Mike Peirce
Danbury, CT

Ed.'s identity will never be revealed, but there have been five or six in this magazine's 66-year history, all too real. Becoming Ed. sort of follows the plot of* The Santa Clause, *except I didn't have anything to do with the last guy falling off a roof. I blame gravity–Ed.

Long-term reader. Missed February and March. Paraphrasing Waylon and Willie: Daddies, don't let your mammas renew your subscription.

–Scott Blount
Bainbridge Island, WA

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PRINTED IN THE U.S.A.
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Why should I care about EVs?

1

A good story always comes with a hefty dose of tension. Like a romance set on the decks of a cruise ship that everyone knows is about to sink. Or a superhero movie twisting time and space to keep you wondering whether the good guys will get hold of the gems before the bad guy wins (again). Last fall, when we were brainstorming stories for 2021, the idea of sending most of the staff on a long road rally in electric cars seemed perfect. Inject a little range anxiety into a trip and you have the makings of a fun tale.

Turns out, our timing was pretty good. Ever since we started plotting the rally, automakers have unveiled more and more plans for more and more EVs of all shapes and sizes. According to IHS Markit, electric vehicles accounted for just 1.8 percent of the market last year, but analysts predict that number will rise to more than 10 percent by 2025. Love them or hate them, you'll be seeing many more EVs on the road in the next few years.

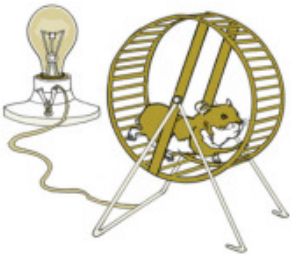
It will take a shifting mindset for traditional car enthusiasts to learn to love EVs. When you've spent your years understanding engine purrs and roars as indicators of something very right (or wrong), chucking a quiet EV into a few corners can be jarring, and many of the canned noises automakers offer for false feedback are too alien to be cool. It can feel like something elemental is missing. After driving 11 electric cars for three weeks, we realized that EVs require a certain recalibration of what qualifies as fun. Which doesn't mean the new fun isn't as good as the old. Accelerating onto the highway with all of that immediate torque at your foot is a blast. Stopping to charge for a half-hour every now and then on a road trip lessens the pressure to just power through to your destination.

You can stomp and moan about change, but it is inevitable. When the first human built a hut, some caveman undoubtedly complained it wouldn't be as sturdy as his cave. And he wasn't necessarily wrong, but the hut gained market share anyway. Change is coming, and we plan to embrace it, critique it, and push the industry to keep making cars that enthusiasts of all stripes can love.

SHARON SILKE CARTY
EDITOR-IN-CHIEF

2. Where will the electricity come from?

EV advocates regularly bust two myths that our electric infrastructure can't support EVs en masse. The first suggests that the rising volume of EVs will demand so much power that utilities won't be able to supply it. On the contrary, these companies have no problem supplying electricity to EV buyers—presuming most



charge their cars overnight. That's when extra generation capacity goes unused because demand is lowest. Many utilities already offer cheaper rates to incentivize off-hour energy use, and every EV on sale today allows you to schedule charging—so you can plug in your vehicle when you park and delay charging until the lower rate kicks in.

The second myth: EVs will bring down the electrical grid. In neighborhoods with many EVs, a higher-capacity transformer may be needed, but utilities are used to making those upgrades as new construction increases electrical demands. Adapting for increasing numbers of EVs shouldn't be any different.

A 2019 Department of Energy report found that the mass adoption of EVs "will not pose significantly greater challenges than past evolutions of the U.S. electric power system." In the long run, EVs may even add stability to the grid. Ford says the F-150 Lightning will eventually be able to power a house during peak demand to save homeowners money and ease pressure on utilities.

3

How does the outside temperature affect range?

The further the ambient temperature deviates from the mid-70s, the more energy is devoted to keeping the cabin's occupants—and, in some cases, the battery—comfortable. Because extreme temperatures can irreversibly damage battery cells, EVs will heat or cool the pack as needed to protect it. Testing five EVs in mixed-use driving with the HVAC systems running, AAA found that, on average, range dropped by 41 percent when the temperature fell from 75 degrees to 20. At 95 degrees, range was reduced by 17 percent compared with the 75-degree baseline. Drivers can somewhat reduce the range-zapping effect of extreme temperatures by scheduling their departures—all EVs have this capability—so that the cabin and battery are preconditioned while the vehicle is plugged in and using power from the grid.

4

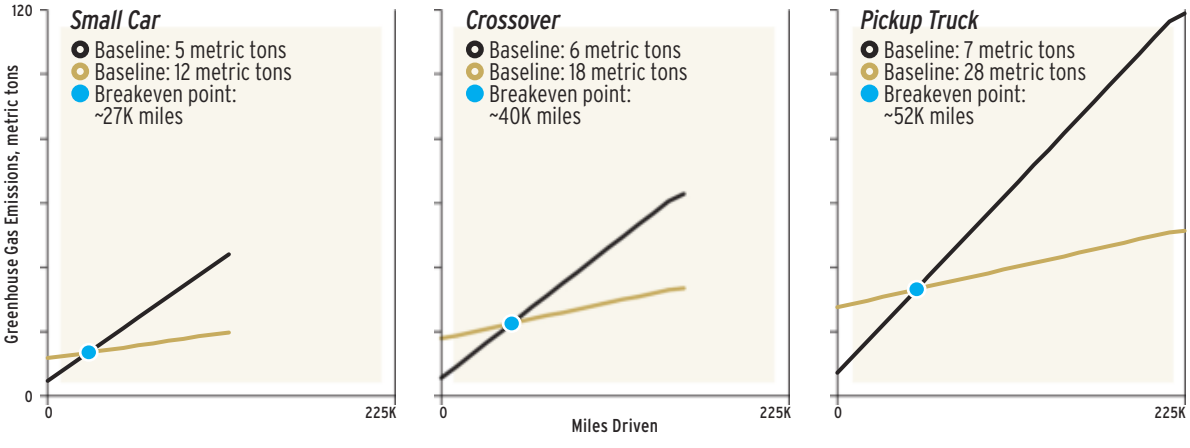
Are EVs actually environmentally friendly?

If we only built cars and never drove them, Camaros, not Model 3s, might be the darlings of the environmental movement. EV batteries are energy-intensive to manufacture, and there are humanitarian costs associated with mining the metals they rely on. Though EVs don't emit greenhouse gases, the electricity they pull from the grid often does.

But EVs are absolved of their original sin pretty quickly once the rubber hits the road. According to a model devised by the automotive consulting firm FEV, the life-cycle emissions of a small gas car will surpass those of a small EV after roughly 27,000 miles of driving. Electric crossovers and trucks are less efficient than small EVs, and FEV's model assumes they'll have larger batteries, so it'll take more mileage to overcome the emissions associated with manufacturing and recycling them. But even the largest EVs should pull even with their gas counterparts by 60,000 miles.

These calculations assume an EV is being charged on a grid powered 50 percent by renewable energy and 50 percent by nonrenewables. Overall, about 20 percent of the electricity generated in the United States last year came from renewable sources, but some states far exceed that, with Washington (78 percent) and Vermont (100) leading the way. The amount of electricity from renewable sources is increasing. Michigan utility company Consumers Energy plans to add enough solar capacity by 2040 to cover its average summer demand. So an EV you buy today will only become earth-friendlier. We can't say the same for a Camaro.

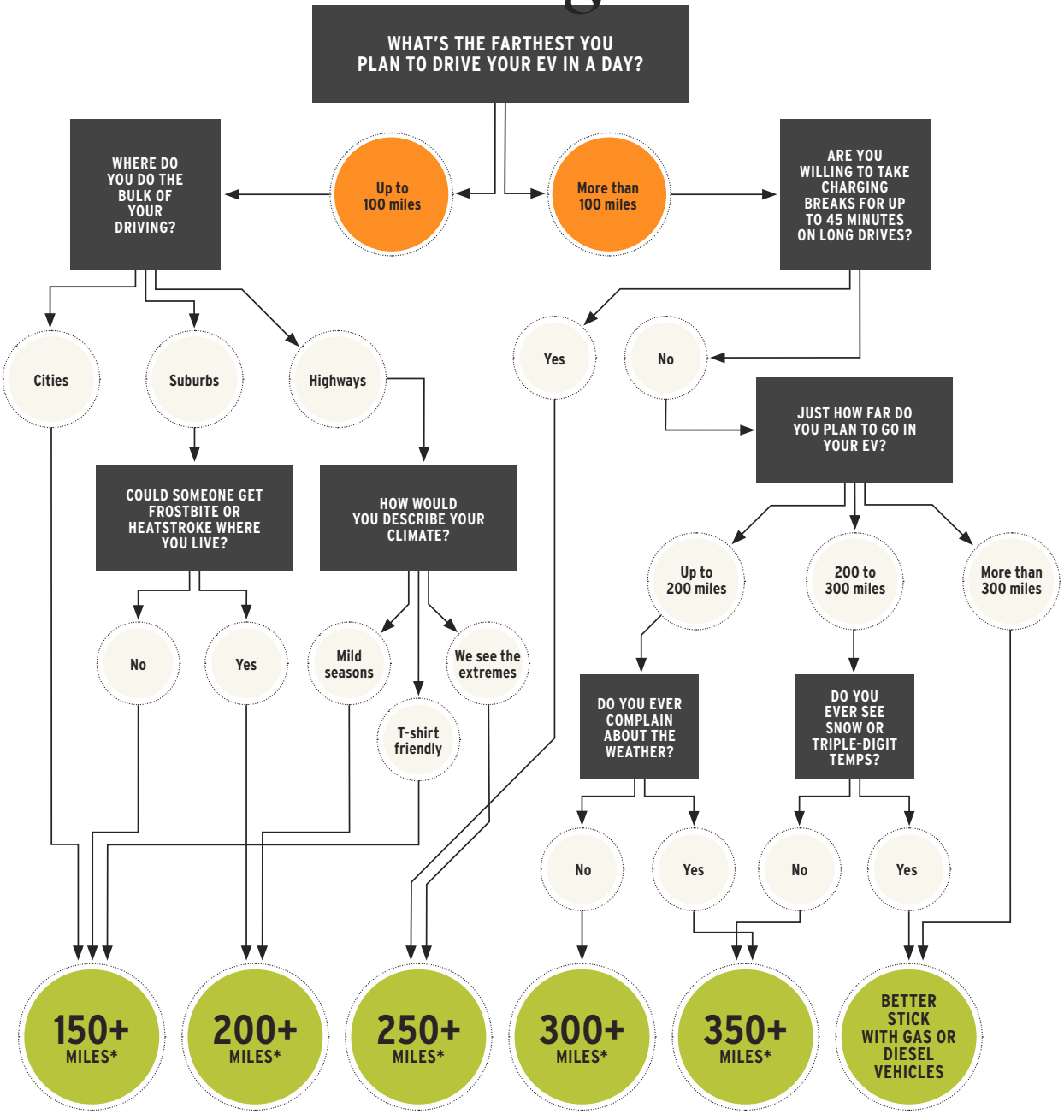
Electric vs. Gas Life-Cycle Emissions ● Gas Vehicle ● Electric Vehicle



5. Should I worry about the electromagnetic radiation an EV gives off?

You can put away your tinfoil hat and lead underpants—your electric vehicle is safe. It's true that an EV's powertrain components—battery pack, wiring, motor(s)—produce more electromagnetic radiation than an internal-combustion engine, but it's negligible. The Norwegian research group SINTEF found that radiation readings inside an EV were well below the limits recommended by the International Commission on Non-Ionizing Radiation Protection. Radiation exposure near the vehicle floor is less than 20 percent of the limit, and at head height, it's less than 2 percent.

6. How much range do I need?



*EPA range.

7. Can I tow with an EV?

We wouldn't recommend it. When manufacturers design EVs, towing isn't top of mind. Several models on the market today don't have tow ratings, and those that do can tug only modest loads. It makes sense: EVs are aerodynamically slippery, and attaching a trailer to one is like strapping a parachute and ankle weights on a marathon runner. Of the 11 vehicles featured in our EV of the Year test [see page 38], the Audi e-tron is rated to tow the most, 4000 pounds, which made it the perfect test bed to pull 3859 pounds of ski boat and trailer. We drove at the speed limit on a 60-mile loop—80 percent of it on a 70-mph interstate—with and without the boat in tow, and not that surprisingly, the vehicle reported twice the consumption with the skiff on its bumper. Twice the consumption means half the range.

8

Are plug-in hybrids brilliant or dumb?

Plug-in hybrids (PHEVs) as a whole are hard to characterize because there are so many approaches to combining gas engines and electric motors in a single powertrain. To figure out whether a given PHEV is worthwhile, simply consider this: Does it have useful electric range and a powerful-enough motor (or motors) to exploit that range without the combustion engine kicking on? That's crucial, because the ideal PHEV-use scenario is everyday electric driving combined with the long-distance convenience of gas. You want one with an electric motor that makes more than 100 horsepower and is good for at least 20 miles on electricity. As a shortcut, look for a PHEV that qualifies for the full $7500 federal tax credit—an indication that it's serious about its electric range. Which brings us to an obvious point: A plug-in will always be a dumb purchase if you never plug it in. The EPA scores the PHEV Jeep Wrangler 4xe at 20 mpg combined once the battery is depleted. The four-cylinder Wrangler—which weighs 800 pounds less, according to Jeep—beats it with a 22-mpg estimate.

9. What happens when an EV runs out of juice?

As an EV's battery gets to a very low state of charge, the vehicle typically reduces the available power and alerts the driver to find a charging station or pull over. At this point, if you can't plug in, range anxiety devolves into panic, which is usually followed by a call for help from the side of the road. As in gas-powered cars, automakers' approaches to distance-to-empty readouts vary. In some EVs, such as the Audi e-tron and Jaguar I-Pace, zero means zero. We have the tow-truck receipts to prove it. Others, such as those made by Ford, Tesla, Volvo, and Polestar, provide several miles of buffer even after the predicted range is down to nil. Here's another wrinkle: After the high-voltage battery pack is dead, you run the risk of depleting the 12-volt accessory battery. If that happens, the vehicle won't charge until the accessory battery is replenished. Consider yourself warned.

10

What do all these new terms and acronyms mean?

BEV
Battery-electric vehicle.

CCS
Combined Charging System, the DC fast-charging connector most automakers use in the U.S.

CHAdeMO
CHArge de MOve, an uncommon DC fast-charging connector. The Nissan Leaf and Mitsubishi Outlander PHEV are the only vehicles currently on sale in the U.S. with this port.

Charger
The onboard hardware in an EV responsible for converting alternating current to direct current to charge the battery. Commonly misused to describe a charging station or the cord that connects an EV to an electricity source. See: EVSE.

EVSE
Electric-vehicle supply equipment, the industry term for what most folks refer to as a charger. It includes public charging stations and other equipment carried in the car or installed at home to connect the EV to a source of electricity.

ICE
Internal-combustion engine. Also used as a verb when an ICE car is parked in a space designated for EV charging, thus preventing an EV driver from plugging in. Example: "I couldn't charge my Tesla because some jerk ICE'd the spot with their brodozer."

J1772
The SAE standard for EV charging and the connector all non-Tesla EVs in the U.S. use for Level 1 and 2 charging.

kW
Kilowatt, equal to 1000 watts, a unit of power commonly used to describe electric-vehicle charging and the power output of an EV's motor.

kWh
Kilowatt-hour, a unit of energy equal to 1 kilowatt being sustained for one hour. A gallon of gas contains approximately 33.7 kWh of energy.

Level 1
Describes 120-volt AC charging with a power output around 1 kilowatt, which typically adds no more than five miles of range per hour.

Level 2
Describes 240-volt AC charging you might see at homes, offices, and shopping centers. Level 2 connections typically offer 6 to 19 kilowatts and can fully charge an EV overnight, but the charging rate may be limited by the onboard charger too.

Level 3
High-power, direct-current fast-charging, which bypasses an EV's onboard charger to feed the battery pack directly. Typical power ranges from 50 to 350 kilowatts, which allows an EV to gain substantial range—100 miles or more—within an hour.

MPGe
Miles per gallon of gasoline equivalent, a measure of efficiency for EVs, PHEVs, and hydrogen fuel-cell vehicles that can be compared to a gas vehicle's mpg.

PHEV
Plug-in-hybrid electric vehicle, which uses both internal-combustion and electric power sources and has a battery that can be charged by plugging in.

Regenerative braking
Using the electric motors to decelerate a vehicle by converting kinetic energy into electricity, which is stored in the battery pack.

SOC
State of charge, the level of energy currently stored in a battery pack expressed as a percentage of its usable capacity.

11. When will Americans start buying EVs in large volumes?

"It's all about the combo of the right body style at the right price point at the right range and getting the consumer confident about access to charging infrastructure, whether it's public or at home. Part of me wants to say now, because you can almost check all the boxes. But by 2025, I think it will be a whole different game. In the next four years, we'll achieve that scale."

—Lea Malloy, head of research and development, Cox Automotive

12. Does an EV's battery degrade like a cellphone's?

Yes. A battery pack's ability to store energy will deteriorate based on numerous factors. Charging habits are the biggest variable. Replenishing to maximum capacity and running the battery down until you see the "Pull over now" warning will weaken the anodes within its cells. To increase longevity, manufacturers typically recommend charging to a threshold of 80 to 90 percent for daily use. GM claims it's found a way to avoid this strain [see page 26], but no one has a good solution to combat battery deterioration caused by extreme climates.

Most automakers warranty their packs for eight years and 100,000 miles. Our long-term Tesla Model 3—covered for 120,000 miles—has lost 7.6 percent of its battery capacity over 33,000 miles. If this rate persists, we'll come just shy of qualifying for replacement under Tesla's 70-percent-capacity-retention policy.

13. How do I prep my garage for an EV?

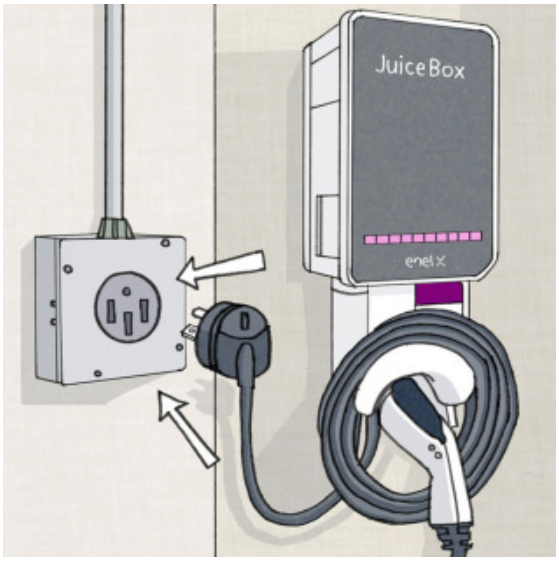
You'll want a dedicated 240-volt circuit for charging your car. A professional installation generally runs between $750 and $1750, plus the price of permits, according to Qmerit, a company that specializes in this kind of work. If your current electrical supply can't handle the extra load, you'll need a new service line run to your house, pushing your cost to the high end of that range. A modest house with 150-amp or higher service can perhaps squeeze in an additional 30- or 40-amp circuit, but it depends on whether there are other large draws, such as a tankless water heater, an electric stove or dryer, or a hot tub. In addition, you may have to purchase charging equipment to connect your EV to the new circuit.

WIRING

The distance from the electrical panel to the charging location can alter the cost substantially. A 40-amp circuit requires 8-gauge wire at more than $3 per foot. Stepping up the amperage for faster charging requires thicker-gauge wire, which costs more.

OUTLET

We recommend installing a NEMA 14-50 outlet rather than hardwired charging equipment. Some EVs come with portable charging cords that work on both 120- and 240-volt circuits, saving you from an additional purchase. And even if you do buy home charging equipment, having a plug-in unit means you can use the outlet for other high-draw equipment, such as a welder, and take the pricey box with you if you move.



EQUIPMENT

Because we're nerds, we like to know how much energy our EVs are using. The Wi-Fi-connected JuiceBox ($650) has a handy app to track charging history and the amount of energy dispensed during each session. You can also schedule charging for set times—a useful feature if your electric utility offers a lower rate during off-peak hours.

14. Can I own an EV without home 240-volt charging?

Sure, just like you can theoretically browse today's internet with a 14.4k dial-up connection. A standard 120-volt (a.k.a. Level 1) household plug adds only a few miles of range per hour, so replenishing a large battery pack from empty can take days. You might be able to make do if you regularly drive less than 30 miles a day or have access to charging equipment at work. Using a local DC fast-charger like it's a gas station might be tempting, but it comes at a cost. Charging at Electrify America stations can be more than three times as expensive as using residential electricity, and fast-charging can reduce a battery's longevity. A survey by UC Davis found that 21 percent of Californians who owned a plug-in eventually gave up on the technology. Among those who quit the electric life, 71 percent did not have 240-volt (Level 2) charging at home.

15. How does the EV tax credit work?

Come filing time, it gives new-EV buyers a one-time break ranging from $2500 to $7500 depending on the vehicle's gross battery capacity (we report usable battery capacity, which is always lower). But there's a catch: If your taxes don't exceed the amount your vehicle qualifies for, you won't get a check in the mail for the difference. For example, someone whose income puts them on the hook for $5000 over the course of the year can't pocket $2500 from a $7500 credit. In 2020, a single person would've needed a taxable income of at least $53,200 to qualify for the full kickback. Another thing to look out for: Once a carmaker has sold 200,000 plug-in vehicles (so far, that's just GM and Tesla), the credit enters a yearlong phaseout period, after which vehicles that manufacturer sells become ineligible. If all of this sounds too complicated, consider leasing. Though the automaker claims the tax credit, many pass those savings on to you in the form of a lower monthly payment.

16 *Are used EVs the bargains they appear to be?*

While Teslas hold their value relatively well, EVs in general depreciate quicker than gas-powered cars. On average, after three years, EVs lose 13 percent more of their value than gas sedans, according to a study from iSeeCars.com. For a good deal on a great car, we recommend looking for a Chevy Bolt, a former 10Best winner. Cars with under 30,000 miles go for less than $20,000, and the EPA-estimated 238 miles of range is competitive with what several $50,000-plus new EVs can manage.

When shopping for used electric vehicles, maintenance history is less of a concern than with gas cars, but you'll want to verify the health of the battery. The easiest way to do this is to fully charge the vehicle and see how the predicted range compares with the original advertised range. Are the numbers close? If so, good. Also, while a "Southern car" may be a selling point for a gas-powered vehicle, that's not necessarily the case for an EV; hot climates can take a toll on battery health.

17 Is an EV cheaper to own than a gas car?

This one's too close to call. We calculated the five-year cost of ownership for the electric Volkswagen ID.4 and the similarly sized and equipped gas-powered Tiguan. The ID.4's higher price means more interest if you're financing (our figures are based on a 60-month loan at 3.11 percent APR with $3000 down). The EV is also more expensive for a 29-year-old man to insure, per GEICO. And Black Book tells us the ID.4 will retain just 32 percent of its value compared with 41 percent for the Tiguan. But the EV saves on maintenance and fuel (assuming 10,000 miles a year with gas at $2.96 per gallon and electricity at $0.13 per kilowatt-hour). With the federal tax credit, the total five-year costs are nearly equal.

	VW ID.4 1st Edition	VW Tiguan SEL FWD
Base Price	$45,190	$33,740
Financing	$3420	$2492
Fuel	$2275	$5920
Maintenance	$330	$1065
Insurance	$8620	$6994
Resale Value	($14,461)	($13,833)
Tax Credit	($7500)	–
Five-Year Cost	$37,874	$36,378

18. Will EVs ever be as affordable as today's cheapest gas cars?

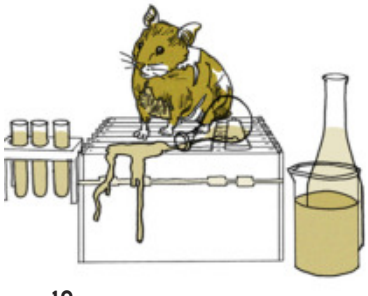
"I believe it's possible to get EVs close to about $20,000, but that will depend on segment and range. That could be the case for small cars in the U.S. by 2030. By then, they could have an efficiency of 0.23 to 0.25 kilowatt-hours per mile, and a roughly 50-kWh battery—providing about 200 miles of real-world range—would be less than $3000." *–Nikolas Soulopoulos, analyst, BloombergNEF*

19

Is a battery breakthrough imminent?

Investors have poured billions into research on more advanced batteries, with solid-state cells the most promising contender. They would replace today's liquid electrolyte—the solution ions travel through as a battery charges and discharges—with a solid material. Solid-state cells promise greater energy density, reduced costs, and lower risk of fire than conventional lithium-ion batteries. But developing new types of cells, from the first lab tests to widespread implementation in EVs, has historically taken a decade.

Carmakers are optimistic for the long term: Toyota does its own R&D on solid-state cells, Volkswagen has backed QuantumScape for years, and Ford and BMW recently increased their investments in Solid Power. The first EVs with these cells could arrive as soon as 2025, but high initial costs may confine them to the top end of the market. We predict that affordable EVs using this tech are at least a decade away.



20. Is now the right time to buy an EV?

"I'll wait till next year." Stalling on an electric-vehicle purchase has been a tempting strategy since the inception of the modern mainstream EV. Year by year, range increased, charging got easier, and manufacturers rolled out better electric options. But as barriers were removed, so too were early-adopter perks. Tesla stopped giving away free electricity at its Superchargers. GM and Tesla vehicles became ineligible for the federal tax credit. Primo parking spots with Level 2 charging are no longer perpetually empty, awaiting the stray futurist in a Model S. This is the inflection point.

The next year brings a mother lode of new EV models at a time when charging infrastructure is expanding and a $7500 federal tax credit is mostly still in play. Until now, electric powertrains were largely confined to expensive luxury vehicles or gas-econobox conversions that were produced to check a regulatory box. Soon we'll see a $42,000 Ford with a frunk (the F-150 Lightning) and a 1000-hp crab-walking beast with T-tops (the GMC Hummer EV)—and those are just a couple of the trucks.

In some of these cases, your purchase involves that $7500 tax credit, which was originally conceived to sweeten the deal on vehicles that presented a questionable cost-benefit analysis. But consider the Lightning: Uncle Sam is paying you to buy a 563-hp truck that doesn't need gas and can power your house in the event of an outage—a.k.a. something you probably very much want anyway. Each manufacturer can sell 200,000 plug-in hybrids or EVs before the tax credit for its vehicles is phased out. With Ford also building the excellent Mustang Mach-E, we're guessing you wouldn't want to dally on either of its EVs. Same goes for the Kia EV6, the Hyundai Ioniq 5, and, praise be to Stellantis, the Jeep Wrangler–based Magneto. Fine—that one might be over a year away. But something always is.

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MODEL F

FORD HOPES ITS F-150 LIGHTNING DOES FOR EVs WHAT THE ASSEMBLY LINE DID FOR THE PERSONAL AUTOMOBILE.
BY ANNIE WHITE

PHOTOGRAPHY BY JOHN ROE

IT'S BEEN MORE THAN A DECADE SINCE THE FIRST MODERN

mass-market electric vehicle went on sale. EVs have come a long way, but they make up less than 2 percent of the U.S. vehicle market. That could change with the F-150 Lightning, the EV version of Ford's half-ton pickup. If even 1 percent of F-150 buyers went electric, sales would surpass 2020 numbers for the Audi e-tron, Kia Niro EV, and Porsche Taycan, among others.

In the United States, F-series models have topped the bestselling-vehicle list for 39 consecutive years, raking in mountains of cash for Ford and filling parking lots with blue ovals. If Ford were to spin off the F-series, the resulting brand would pull in $42 billion annually—more revenue than Nike, Coca-Cola, and Netflix.

This is the third time Lightning has struck the F-series; the name dates back to the 1990s. While priorities shift with the 2022—earlier Lightnings didn't give a rip about fuel economy—that doesn't mean Ford is asking buyers to sacrifice utility in the name of efficiency. The new Lightning hews close to the F-series identity.

Which is to say, the F-150 Lightning is the perfect candidate to attract the type of interest EVs will need to make the jump from rarity to ubiquity. Stephanie Brinley, an analyst with IHS Markit, says that for EVs to become more popular, "electric propulsion systems have to be in vehicles we already want." What truck buyers

The Lightning's interior looks remarkably similar to the gas F-150's, with one big exception: The 15.5-inch touchscreen is available only to EV buyers. It comes standard on the Lariat and Platinum trims.

want is supreme capability, and the Lightning looks as though it'll deliver exactly that.

Available only with a four-door SuperCrew cab and a 5.5-foot box, it's an inch longer and 1.7 inches taller than the similarly equipped gas F-150, with almost the same width and wheelbase. Buyers will have a choice of two lithium-ion batteries: Ford hopes for 230 miles from the standard-range pack and 300 from the extended-range unit. We expect their capacities to be at least 115 and 150 kilowatt-hours, respectively.

Every F-150 Lightning delivers full-time all-wheel drive with two motors. The powertrain with the smaller pack is tentatively rated for 426 horses; the bigger one ups the ponies to 563. Ford says the truck with the latter will reach 60 mph in the mid-fours. For reference, the quickest F-150 we've ever tested, the 2017 Raptor, hit the mark in 4.9 seconds, and neither the 1993 nor 1999 Lightning cracked five seconds.

Unlike every half-ton truck that came before it, the Lightning employs an independent rear suspension made up of semi-trailing arms, coil springs, and an anti-roll bar. By ditching the stick axle and installing a heavy battery pack, Ford has lowered the F-150's center of gravity, which could make the Lightning a dynamic standout in an otherwise oafish class.

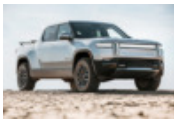
Ford says the big-battery truck will tow up to 10,000 pounds (two tons less than the mightiest gas-powered F-150) and the small-battery model will manage 7700. The latter boasts the higher payload, 2000 pounds to the former's 1800. The automaker hasn't commented on how range will shrink with a trailer attached, but our back-of-the-envelope math suggests that the Lightning could struggle to go 100 miles between charges when maxing out its towing capacity.

Brinley says that EVs also need to offer something combustion models can't if they're going to achieve big sales numbers. Ford knows this and made strides to include special features in its electric truck. For instance, it's offering an 80-amp charging station that, when

A TRUCKLOAD OF EVs IT'LL BE A CROWDED MARKET IF ALL OF THESE PLANNED ELECTRIC PICKUPS MAKE IT INTO PRODUCTION — BUT THAT'S A BIG IF.

GMC Hummer EV
Arriving this fall with 1000 horsepower and a curb weight exceeding 9000 pounds, the $112,595 Hummer EV Edition 1 is the Hummer of EVs. Also, it has T-tops.

Chevrolet Silverado EV
GM will build the electric Silverado on the same Ultium platform that underpins the Hummer EV—meaning it's not an adapted internal-combustion truck but a total rethink. Range is expected to be over 400 miles. No word yet on when it'll reach production.



Rivian R1T
Quad motors deliver a claimed 60-mph time of 3.0 seconds; a full-width compartment between the cab and bed can house gear. The (sold-out) Launch Edition arrives this year.

Tesla Cybertruck
Tesla says its pickup will have up to 500 miles of range and a 60-mph time as low as 2.9 seconds. It's slated to arrive later this year, but Tesla has to finish building the factory first.

Bollinger B2
The ambitious $125,000 B2 uses a hydropneumatic suspension to make possible a 5000-pound payload rating and 15.0 inches of ground clearance. Production is slated for late 2021.

Lordstown Endurance
Conceived as a commercial vehicle, the Endurance has 600 horsepower and an 80-mph top speed. We suspect that reservation holders will require some endurance of their own.

A SILVER TOYOTA CAMRY — Chance of Actually Happening — A 200-MPG CARBURETOR

LORDSTOWN PHOTOGRAPH BY MEGAN JELINGER/AFP VIA GETTY IMAGES

ARE TRUCKS THERE YET? WHY PICKUPS AREN'T READY FOR THE EV TREATMENT.

Battery-electric vehicles don't scale well. Large EVs weigh a lot and punch big holes in the air, which means they need a lot of power to move, which requires a large battery, which adds more weight, which requires more power, which requires a bigger battery. It's a vicious cycle that will end only with a battery-technology breakthrough. Although the same laws of physics apply to both electric and combustion-engine trucks, today's EV tech means swapping 200 pounds of fuel for an 1800-pound battery. And by the way, that battery holds a fraction of the energy that's in a full fuel tank.

It's a problem of road load and the power required to overcome those forces acting against a vehicle as it maintains a given speed. The Tesla Model S needs 24 horses to maintain 75 mph. A four-plus-ton GMC Sierra 2500 needs nearly 71 ponies. The road load of the Lightning will far surpass the Model S's. And as soon as owners start saddling trucks with toys, road load climbs even higher, tanking range. Then anxiety's ugly hand will grab hold and pull many buyers back to gasoline or diesel.

I have no doubt that electric pickups will be a success. I'm equally confident that the boom will be short lived. The uniquely American desire to commute in three-plus tons of metal could eventually spark a battery breakthrough, but for now, automakers would be smart to focus on making EVs as light and efficient as possible. *–K.C. Colwell*

The F-150's engine bay has been repurposed as the Mega Power Frunk (yes, it's really called that). The four household outlets and two USB charging ports inside come standard.

properly wired to backfeed a house, can draw up to 9.6 kilowatts from the Lightning for use in power outages—essentially turning your truck into a backup generator that can run for three days. Eventually, through the magic of over-the-air updates, Ford hopes to use this truck-to-house energy transfer to save buyers money on electric bills. The idea is that your truck could power your home during peak usage hours and top itself back up when rates are low. And with a plethora of outlets in the frunk and bed, the Lightning can also serve as a portable power pack at a job site or campsite.

The Lightning's May reveal couldn't have gone much better. Ford got the seal of approval from a gleeful President Biden, who—during a trip to Ford's test and manufacturing facilities the day before the official unveiling—urged reporters to time him while he launched the truck to 80 mph [see "C'mon, Man, This Is a Truck," page 88]. Within 48 hours, 44,500 people had each forked over $100 to reserve one.

While that's a good sign, the electric-pickup revolution isn't a done deal. There's a big difference between paying for a spot in line and shelling out for a whole truck when spring 2022 rolls around. The base Lightning will start at about $42,000, and Ford says the price for a top example will exceed $90,000.

Brinley expects that the Lightning will represent a relatively low percentage of F-150 sales for quite some time. "It's a long-term play," she says. Ford is hedging its bets (have you heard about the new Bronco?). But it may be hedging a little less than it was before the Lightning came on the scene. Since unveiling the truck, Ford has announced plans for an electric version of the Explorer SUV, plus an unnamed "rugged" SUV to follow. If the F-150 brand can weather a pair of electric motors, why not Bronco?

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Before GM could commit to an electric future, it had to figure out how to turn a profit on EVs. The solution lies deep inside the company's new Ultium batteries, which will power nearly all its models by 2035.

~

By Dave VanderWerp
Photography by Roy Ritchie

When GM launched the plug-in-hybrid Chevrolet Volt in 2010, the auto industry talked about battery cost around $1000 per kilowatt-hour of energy storage. At that price, the Volt's 16-kWh pack was likely more expensive than all other components of the car combined.

Now, with GM's latest battery, dubbed Ultium, the company says it's approaching a cost that's 90 percent lower—a point where it can finally be profitable to shift away from internal-combustion engines. The automaker has promised to do just that, launching 30 new EVs around the globe by 2025. Come 2035, its only vehicles with tailpipes will be heavy-duty trucks.

The building block for this plan is a large, pouch-type lithium-ion cell, roughly 23 by 4 by 0.4 inches. It weighs about three pounds and contains 20 times more energy than Tesla's small, cylindrical cells. (Teslas currently have thousands of battery cells in their packs, whereas EVs from GM and most other automakers have hundreds.) The 0.37 kilowatt-hour of gross energy capacity in each cell is enough to propel the first Ultium-powered vehicle—the mammoth 2022 GMC Hummer EV pickup—just over a half-mile. These cells will be produced in a joint venture with LG Chem at two massive new facilities in Ohio and Tennessee. When both plants are up and running by the end of 2023, they'll be able to create a combined 70 gigawatt-hours' worth of batteries every year. That's the equivalent of roughly 190 million cells, or enough for about 750,000 vehicles, by our estimates.

LG has been GM's go-to battery supplier for over a decade, during which time both the size and chemistry of the cells have evolved substantially. Compared with the cell used in the Bolt EV, the Ultium cell, a nickel-cobalt-manganese-aluminum blend, has 70 percent less cobalt, a key to reducing cost. Any LG customer can buy this cell, though, so whatever competitive advantage GM leverages will have to come from how it integrates components into a complete pack. The packs will have net capacities between 50 kilowatt-hours (144 cells) and 200 kilowatt-hours (576 cells), put out between 235 and 1000 horsepower, and provide up to 450 miles of range.

GM claims it's the only automaker right now that can either lay cells flat or stand them upright. That gives engineers flexibility in shaping a pack to follow a vehicle's floorpan. GM bundles the cells into groups of 24, creating a module. In the Hummer, 12 modules are wired in series to make one 400-volt, 100-kWh layer of a double-stacked battery pack. The two layers are connected in parallel to arrive at a total 200-kWh net capacity.

Here's the neat trick: On some Ultium vehicles, such as the Hummer, the top and bottom layers can be temporarily switched from a parallel to a series connection, doubling the voltage to 800.

This lets it take full advantage of the highest-output 800-volt Electrify America fast-charging stations. Fittingly, the Hummer's ability to charge at 350 kilowatts means it can draw electricity quicker than any EV on the market today. By switching the pack from 400 to 800 volts for fast-charging, GM avoids paying for the more expensive componentry that's required for an EV to operate at the higher voltage all the time, as the Porsche Taycan does. The Taycan is currently the only EV out there that's capable of charging at 800 volts, albeit at a lower 270-kW peak.

DC fast-charging, as well as repeatedly topping up a battery to 100 percent, is the most common cause of the degradation that reduces a battery's capacity over time. That speedy charging can cause fast-moving lithium ions to crystallize in the cells, preventing them from moving back and forth as the battery charges and discharges. But Tim Grewe, GM's global electrification and battery systems director, makes some bold claims for the Ultium pack. He says no amount of DC fast-charging will degrade its capacity, and unlike Tesla and others, GM will not suggest the pack be charged to less than 100 percent during normal daily use. He credits the breakthrough to the careful development of the chemistry, including the addition of aluminum into the cell. Grewe also promises that the Ultium pack "will last longer than the Bolt EV's," which he says is making it to between 150,000 and 250,000 miles in the real world, comfortably past its 100,000-mile warranty.

GM's so-called megashaker thrashes battery packs with a lifetime's worth of vibrations in a matter of days. Similar equipment is used to ensure that satellites survive the brutal blast into orbit.

Typically, automakers need a throng of wires to monitor the hundreds of individual cells in a pack. But GM found a way to monitor the Ultium's wirelessly. Each group of two or three cells wired in parallel broadcasts key information such as temperature and voltage several times per second. This reduces the pack's wiring by 80 percent compared with the Bolt's—eliminating a source of warranty claims, improving packaging, and simplifying the wiring harness. Plus, GM claims this setup consumes no more power than a wired system.

GM develops and tests the packs in its 100,000-square-foot battery lab in Warren, Michigan. The company's 75-ton megashaker looks like a 10-by-10-foot oven perched atop a platform. It jostles a battery around while varying temperature and humidity to the extremes. In a matter of a few days, this exercise imitates the abuse a battery takes from a lifetime of driving over potholes. Elsewhere in the massive lab, packs are charged and discharged repeatedly to simulate a full life cycle. They're subjected to puncture tests and dropped from heights of six and 16 feet to ensure, among other things, that Hummer owners can confidently peacock off-road. Engineers are also learning from the competition: On the day we visited, we saw a workbench full of components from Tesla and Jaguar battery packs.

While GM hasn't yet sold a vehicle with an Ultium pack, the lab is already hard at work on the second-gen cell. Grewe suggests it could as much as double this new cell's energy density. With costs now coming under control, the next big challenge in battery technology is stretching the range and slashing the weight of today's packs.

STACKS ON STACKS

This is the layout of the largest Ultium battery—the double-stacked, 24-module Hummer pack—which has a net capacity of 200 kilowatt-hours. The smallest variant will have six of these rectangular modules and hold 50 kilowatt-hours. The 24 cells within each module can be oriented either horizontally or vertically and are monitored wirelessly, both industry firsts.

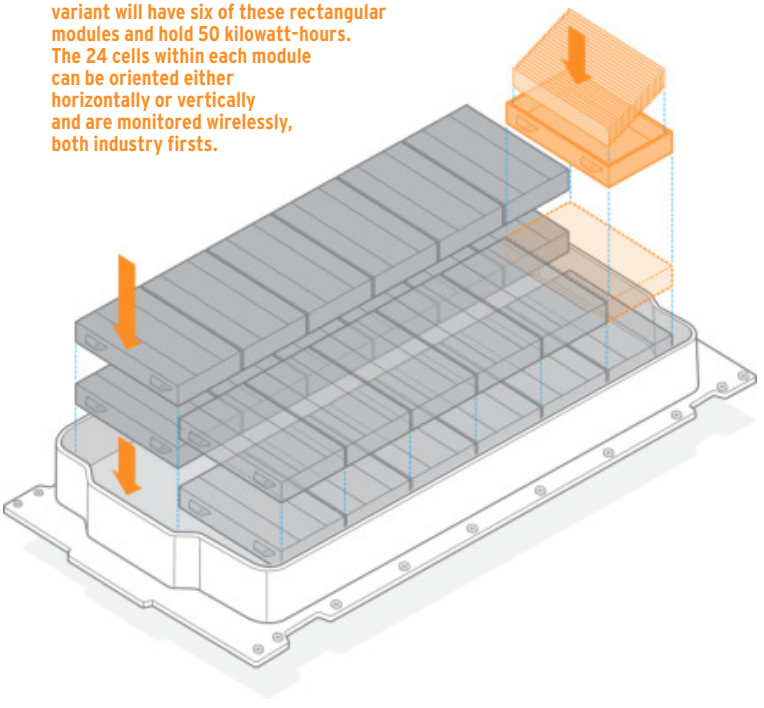


ILLUSTRATION BY CLINT FORD

Nevera Nevera Land

A $2.4 MILLION 1877-HP ELECTRIC HYPERCAR FROM AN AUTOMAKER YOU'VE

It shouldn't be this easy to beat a Bugatti Chiron in the quarter-mile. This level of acceleration should require more driver skill, some rare manual dexterity lacking in Joe Commuter. Admittedly, it's pretty easy to do a full-bore standing-start launch in a Chiron or any gas car that shifts gears for you. But the electric Rimac Nevera's acceleration and its impact on you are so extraordinary, it feels as though it shouldn't be available to just anyone with $2.4 million and enough courage to hold down the accelerator.

You do need to be brave, because the Croatian carmaker's latest creation is unnerving. Find a long straight and bring the car to a stop. Turn the drive-mode selector to Track to enable maximum power. Hold the brake and push the right pedal all the way; the back of the car will squat as the rear motors flex on the suspension. Take a breath and then lift your left foot.

It's not too brutal at first. Unleashing twice the power of a modern Formula 1 car all at once isn't possible, so the rollout is gentle compared with what happens later. In those first few tenths, the Nevera—named for an electrical storm that occasionally ravages the Croatian coast—precisely matches motor output to available grip. Then it goes wild as the rate of acceleration increases with speed. The car goes quicker as it goes faster. Your breathing changes, becoming slightly panicked. The fluid in your eyeballs seems to ripple, distorting your vision. The noise is

NEVER HEARD OF OFFERS OTHERWORLDLY ACCELERATION. ~ *By Ben Oliver*

intense: Four motors scream and whine as 1.4 megawatts—that's 1877 horsepower—pump through them, and four tires rip at the tarmac, constantly on the edge of grip. It takes conscious effort to keep your foot down through the quarter-mile. At the end of our run, we can finally exhale, toss out an expletive, and shake in the wake of the adrenaline.

To make matters even more stressful, Rimac founder and head honcho Mate Rimac came along to watch the proceedings. The Nevera we're sampling is a pre-production prototype. As such, it's particularly important to his business, not to mention that this car represents a major percentage of Croatia's entire car production this year. Rimac intends to produce 150 Neveras, the first 50 of which are already spoken for. Some might even make it to the U.S. market.

After we take a few runs, Mate showed us the Nevera's onboard data logger, which will be available to customers. The car's computer indicated an 8.7-second quarter-mile at 160 mph. Once the launch-control programming is finalized, Rimac promises the car will reach 60 mph in 1.9 seconds, 100 in 4.3, and the quarter in 8.6. Those numbers are nothing more than claims, though. In *C/D* testing, the Bugatti Chiron Sport hit 60 in 2.4 seconds, 100 in 4.4, and the quarter in 9.4 seconds at 158 mph.

So other than terror and what could turn out to be the quickest car in the world, what do you get for nearly two and a half million bucks? Quite a lot, actually. Unlike many small-batch manufacturers, Rimac designs and makes a lot of the Nevera's components in-house. It claims the carbon-fiber tub is the largest and stiffest of any car's. The powertrain has four motors, one per wheel and each with its own direct-drive gearbox. The front motors make 295 horsepower apiece; the rear, 644. The system totals 1741 pound-feet of torque to go along with the combined 1877 horsepower.

Brembo-supplied 15.4-inch carbon-ceramic brake rotors and six-piston calipers work in conjunction with up to 300 kilowatts of regenerative braking to slow the car. They're mighty, if a little sensitive in their current setup.

The key-shaped battery—with an estimated capacity of 110 kilowatt-hours—is located behind the seats but also under them and down the center tunnel. At a 350-kW DC fast-charging station, the battery should recharge from 20 to 80 percent in only 18 minutes.

The active aero package—diffuser, wing, hood vent, and underbody flap—is so smart that in Drift mode it can even optimize the plume of tire smoke behind you for dramatic effect. The car also features a Driver Coach, which uses artificial intelligence to figure out the best line and help you achieve it, telling and showing you when to brake and turn.

Rimac intends for the Nevera to be more than just a feral and extreme racer with plates. This is a usable grand tourer. Climbing in is easy thanks to narrow sills. A 360-degree camera system aids outward visibility. Selectable accelerator maps make the colossal power simple to manage in traffic. The low-speed ride can occasionally get choppy and noisy, with shock transmitted unabated through that ultrastiff structure, but you could use this car as a daily driver. It's no harder to drive than an Acura NSX.

The steering is quick and accurate, though it lacks feel, and the torque vectoring made possible by the individual wheel motors pulls the nose tight to every apex. The ride is mostly fluid, the body control tight, and the roll contained.

The Nevera is no one-trick pony, but the powertrain is definitely the main attraction. Skeptics argue that cars like this have unusable power. The same could be said of a 627-hp BMW M5 CS. The power here isn't excessive; it just seems unlimited. The Nevera has power like the Fed has money. It just cranks out whatever you need. Passing anyone is easy at any speed.

It is a distinctly digital experience but no less thrilling for it. Hypercars like the Nevera may be unobtainium for most of us, but this battery-powered car could topple the Bugatti Chiron as the speed king, and that's significant. If that happens, the internal-combustion engine may never recover.

Because any passenger's brain will struggle to keep up with what's happening, the Nevera includes a display in front of the right seat that shows speed and power.

The Young and the Restless

Acquiring a Bugatti by age 33 would be impressive enough, but acquiring the brand—or at least a major part of it—by 33 is simply epic. Later this year, that's what's happening to Mate Rimac, the man VW believes can best engineer the drivetrains that Bugatti will need in an electrified era.

So how did this guy come to be on the verge of controlling one of the most storied names in motoring? It all starts in the least Bugatti-like manner, with a 20-year-old Mate pulling the blown engine out of his beater E30 BMW 325i and replacing it with an electric motor from a forklift. He eventually pulled that out too, made it better, and has been refining his electric powertrains ever since. What he's learned has allowed him to establish Croatia's first carmaker and create two hypercars. Now the biggest whales in the automotive ecosystem are visiting his tiny, young country, wondering whether its cleverest kid can really give them a shortcut to high-performance EVs.

Seems he can, though they took some reassuring at first. Hyundai Motor Group, one of his earliest clients and investors, has annual revenue four times greater than Croatia's gross domestic product and is used to dealing with known suppliers like Bosch, which itself has annual revenue greater than Croatia's GDP. Porsche (owned by Volkswagen) invested in Rimac back in 2018 and has since upped its stake twice. The Bugatti deal, likely to be announced later this summer, will see Bugatti transferred from VW to Porsche, then put into a joint venture with Rimac, which will be the majority shareholder.

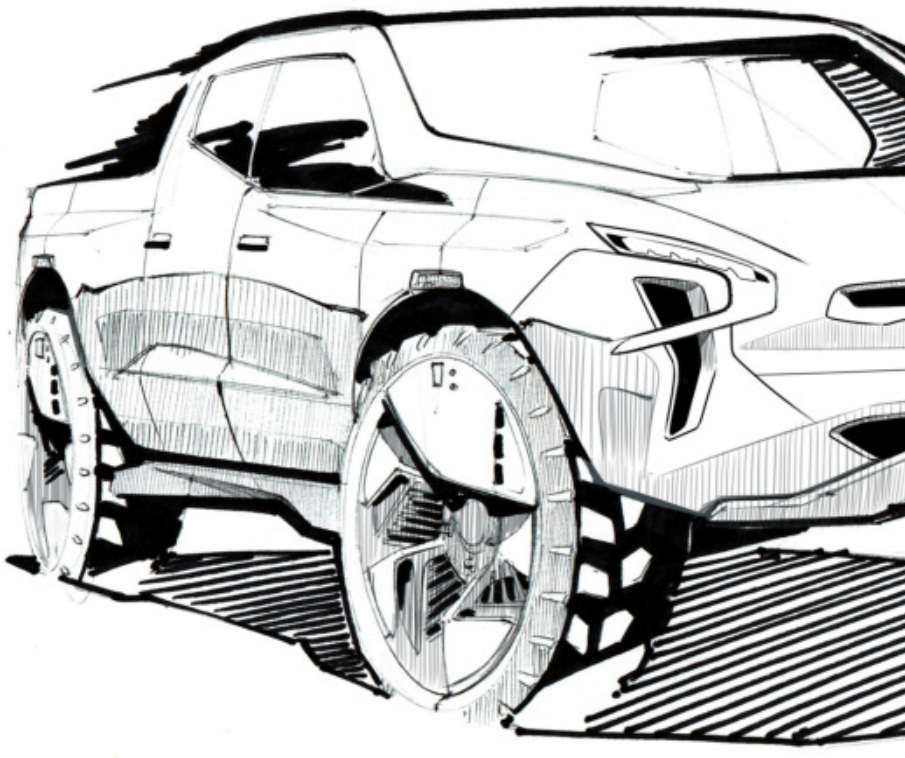
Trusting a whiz kid who grew a beard to look a little older isn't what vast, conservative corporations typically do. But Rimac delivers. The company quickly built a fast portfolio and signed big names. Aside from creating two hypercars, the Concept One and Nevera, Mate has struck deals to supply Aston Martin and Koenigsegg with powertrain components for their hybrid hypercars. The Pininfarina Battista is pretty much a Nevera underneath.

What happens next could be far more significant, though. The company now has active projects with many major European OEMs and contracts in place to supply powertrains—mainly for performance versions of EVs built in volumes of up to 100,000 units per year—to both mainstream and premium automakers. Mate has confirmed one such project with Porsche. The rest remain under wraps, but when these cars arrive sometime around 2025, they will mark a major step up in scale for the company.

To handle the demand, Rimac has commissioned a $240 million campus—one capable of accommodating 2500 workers—on the outskirts of Croatia's capital, Zagreb.

Mate seems remarkably unaffected by his success, despite becoming something of a talismanic figure in his homeland. He certainly doesn't behave like the typical hyperalpha CEO or tech titan. He has, inevitably, been dubbed Europe's Elon Musk, but he declines the comparison and says he doesn't want to meet his hero until he's "achieved a bit more." You might think that building the Nevera, a 1877-hp electric hypercar with the chops to shatter acceleration records, before age 40 would be sufficient justification. But never being quite satisfied is what drove him to make it big in the first place.

A FUNDAMENTAL CHANGE IN HOW CARS MOVE IS LEADING TO AN EQUALLY RADICAL SHIFT IN HOW THEY'RE DESIGNED.



THE SHAPE OF THINGS TO COME

BY ELANA SCHERR

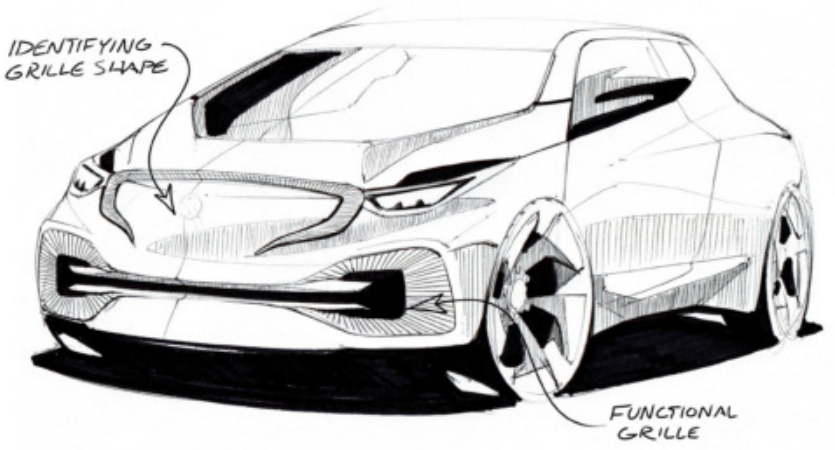
ILLUSTRATIONS BY CLARK MILLS

WHAT SHOULD THE CARS OF THE FUTURE LOOK LIKE? HOW SMOOTH, HOW TALL, HOW SPACIOUS SHOULD THEY BE?

For more than a century, most automotive designers have had to work around an internal-combustion engine and transmission. Gas, diesel, and hybrid powertrains need room to spin and breathe—sometimes to the detriment of passengers. We're so used to stumbling over the hump of a driveshaft tunnel and giving up kneeroom for the sake of a set-back engine that it never occurred to most of us that anything could be different. But in the future, especially the near future, with a focus on electric cars built on new, dedicated platforms, designers have a rare opportunity to reimagine what a car can offer.

Many early EV ventures used existing platforms and arranged electric powertrains to fit where gas engines and transmissions had previously resided. Even Tesla's first attempt was a revamped Lotus Elise without its 1.8-liter inline-four. Working on a nondedicated, or "nonnative," electric platform limited designers' options for positioning the battery and motor. Automakers often stacked batteries under the rear seat—which is why early EVs sometimes offered less legroom or cargo space than their gas counterparts—and put the motor assemblies under the hood. Even the Nissan Leaf, which packages an underfloor battery in a dedicated EV platform, still follows the old philosophy of carrying a motor where an engine normally goes. Aesthetically, too, the early electrics couldn't break away from distinct grille shells and large air vents.

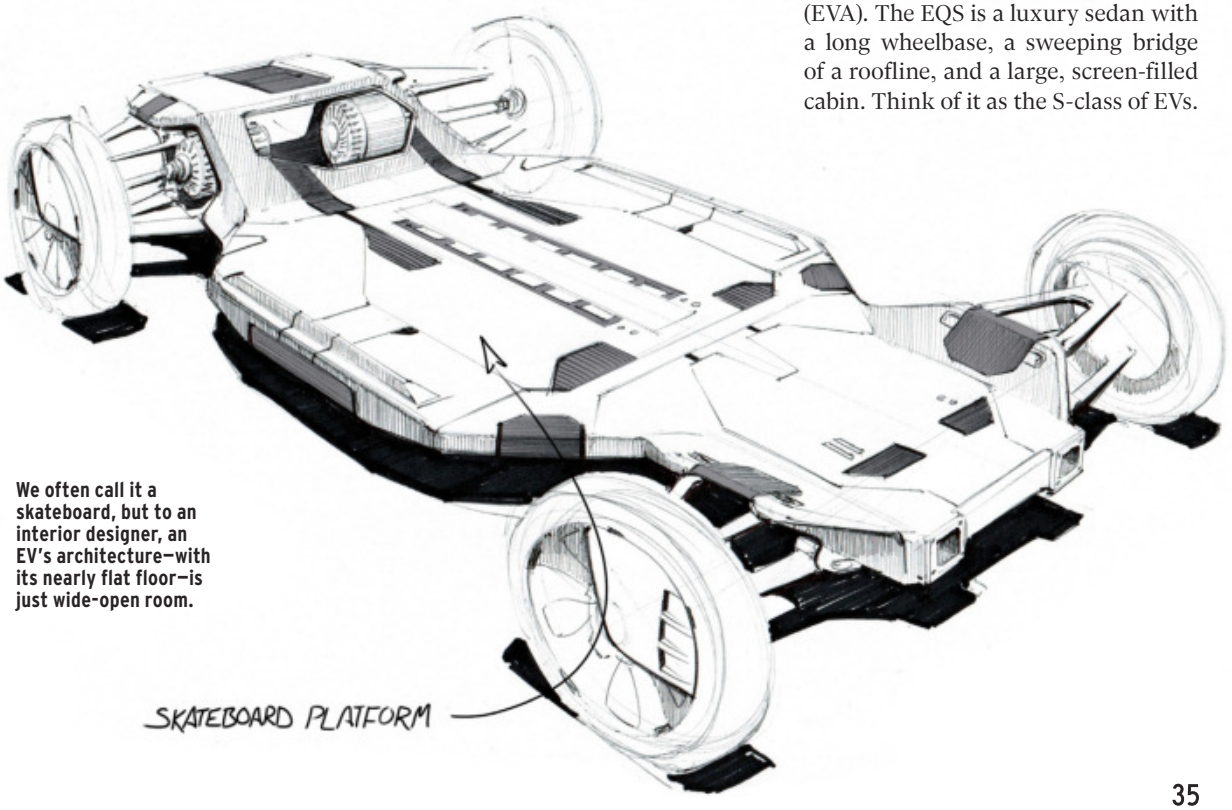
Electric powertrains need cooling, but they don't generate nearly as much heat as an engine, so designers aren't obliged to draw large grilles.



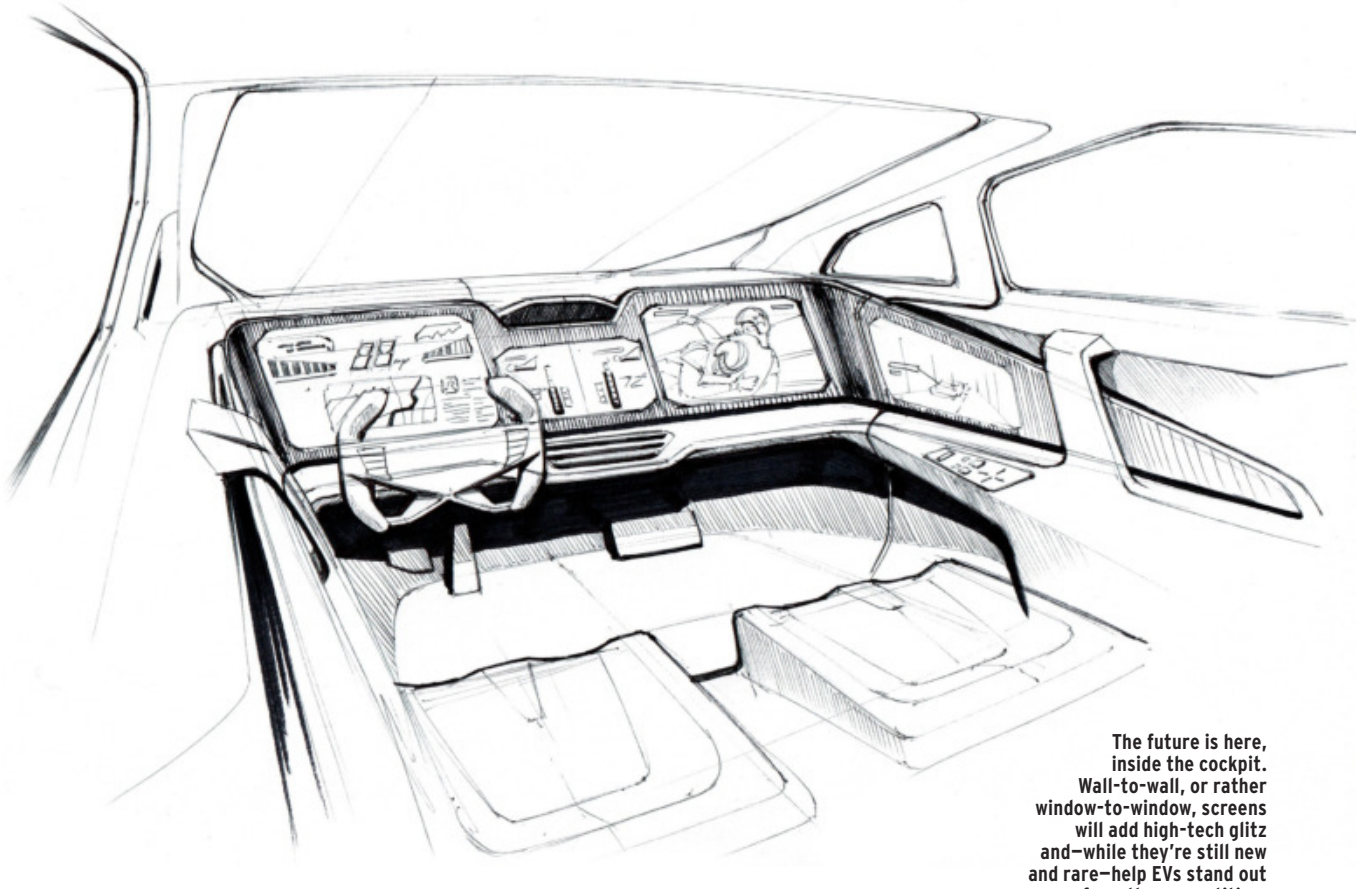
In 2017, the consulting firm McKinsey & Company said long-term use of nonnative platforms for electric-vehicle design was inefficient. Most automakers seem to agree. This year we've seen a wave of new models on dedicated EV platforms similar to the flat-battery, motors-at-the-axles "skateboard" layout Tesla has been using since the Model S launched in 2012. Rearrange the words "global," "modular," and "electric" and pick your platform from a variety of scalable roller skates with acronyms like EVA and E-GMP to see how designers reshape the automobile when they aren't working around an engine.

WHAT'S INSIDE COUNTS

"We have the opportunity to give the car a totally new kind of proportion," says Steffen Köhl, Mercedes-Benz director of advanced exterior design. Köhl worked on the EQS, the first car on Mercedes's new Electric Vehicle Architecture (EVA). The EQS is a luxury sedan with a long wheelbase, a sweeping bridge of a roofline, and a large, screen-filled cabin. Think of it as the S-class of EVs.



We often call it a skateboard, but to an interior designer, an EV's architecture—with its nearly flat floor—is just wide-open room.



The future is here, inside the cockpit. Wall-to-wall, or rather window-to-window, screens will add high-tech glitz and—while they're still new and rare—help EVs stand out from the competition.

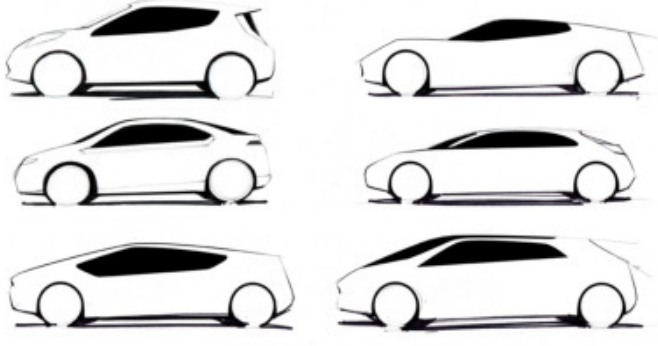
The underpinnings of an EV allow for bigger interiors in smaller vehicles, he says. It can be "cabin-forward, with short overhangs in front and rear. Since the battery is flat ground, we can try a new kind of interior—smooth panels, the center console floating. There are no more ups and downs between the seats."

Escaping the tyranny of the center tunnel is exciting to many designers. Imagine trying to decorate a room with an undulating hardwood floor. Furniture would be pushed to the side, with the center of the space unusable. In cars, designers regularly hide the hump with a shallow console in the front; in the back, they simply cover it with carpet and ignore it. But now that they can smooth out that hump, there's a lot more room to play with. Köhl's team on the EQS used this newly available real estate for an elegant multilevel console with room for a large bag in a pass-through by the driver's knee. In Hyundai's new Ioniq 5, which rides on the Electric Global Modular Platform (E-GMP), the space is left open, giving driver and passenger the opportunity to bump knees romantically at stoplights, although that's not in the press literature. The flat floor also allowed Hyundai designers to put in a deep console that slides rearward so front-seat occupants can enter or exit from either side of the car.

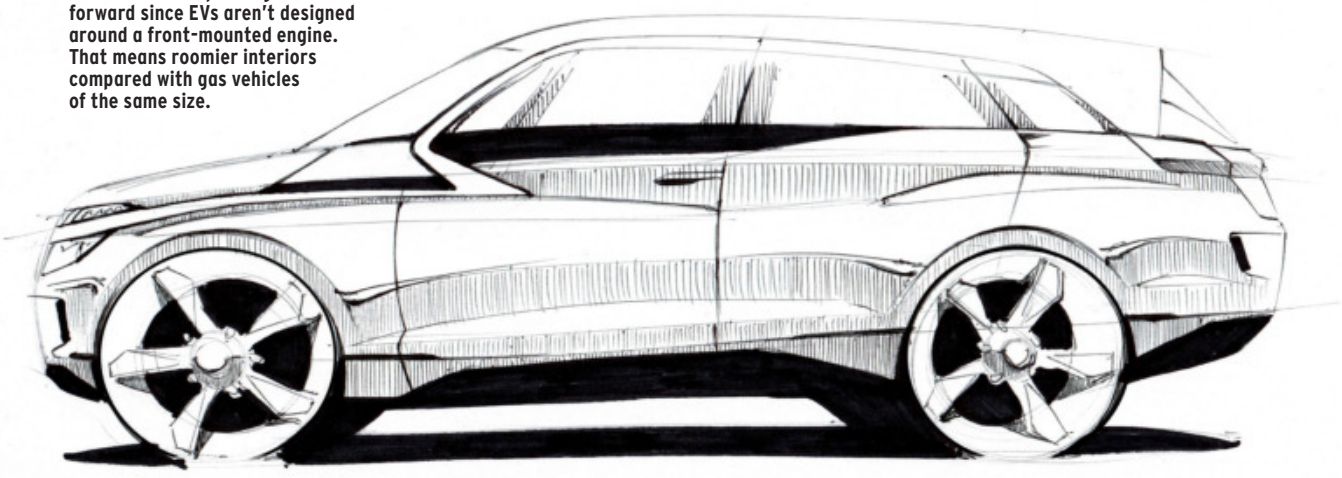
THE GREAT OUTDOORS

Early discussion of EV design was a chorus of moans from car enthusiasts about how designers would become slaves to the wind tunnel, pursuing a coefficient of drag that made everything look like an owl pellet on wheels. This dire prediction has not come to pass. Aerodynamicists have been able to work with shapes that range from the tennis-shoe profile of the Volkswagen ID.4 to the shocking angles of the Tesla Cybertruck to the sports-car smirk of Porsche's Taycan. According to Köhl, the smooth blob that caused the great panic was never a technical requirement; it was more of a marketing choice.

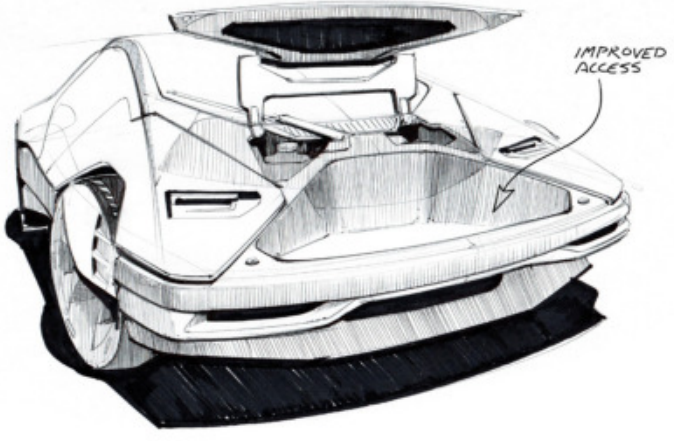
The first modern electric cars "were very much trying to show the world, 'Hey, I'm different. I'm a new thing,'" he says. "You don't need



Early EVs were pretty similar. To get the range out of small batteries, the cars needed to be light, little, and aerodynamic. Cheaper batteries will allow for larger packs, which give automakers the opportunity to enter more segments and designers the freedom to work with more shapes.



Automakers are expanding wheelbases and pushing cabins forward since EVs aren't designed around a front-mounted engine. That means roomier interiors compared with gas vehicles of the same size.



Ditching the engine gives designers a whole new space to play with up front. For now we're seeing it used for storage, but who knows what new ideas will come in the future. It is, literally, a blank space waiting to be filled.

a wheel cover to prove that you're a great electric design. With the EQS, we have a coefficient of drag of 0.20. Perfect drag, no silly disc wheels with no shape. You can create electric design without being so obviously different or ugly."

EV designs from the early 2010s didn't seem to know what to do with the front of a car. Electric motors still need cooling. But with different demands, that cooling doesn't have to come through a large center grille the way it commonly does for an engine. Do you leave the grille because it's already there? Eliminate it, leaving only the smooth profile of what was? Tesla has chosen that road, a decision that once led me to describe the Model 3 as "a Mustang in a bondage mask," thus earning me many angry messages from Tesla fans and a few friendly ones from bondage fans. We are used to a face on a car, though, which is why the grilleless Tesla fascia was so striking. Newer designs are getting playful with the space. Certain Ford Mustang Mach-E models wear a mustache. Köhl's EQS gets appropriately Mercedes fancy, with a glossy field of embedded stars on some trims. The grille has been a brand billboard since Henry Ford first stamped his name on the Model T radiator shell, and while gas-powered cars are being forced to devote more real estate to cooling, EVs can use the space for purely aesthetic choices.

FRONT LOADED

With empty spaces under the hood and behind the rear seat, EVs can offer a massive amount of cargo storage. "Put it in the trunk" leads to the follow-up question, "Which one, back or front?" A front trunk is not a recent invention, but marketing it as a frunk and touting its convenience seem to have started somewhere between Porsche Boxster and Model S.

If Tesla gets credit for mainstreaming the frunk, Ford is taking it to the next level with the F-150 Lightning. The electric version of America's most popular vehicle doesn't play into a lot of the EV design trends we've been talking about. It's not an EV-only body; it uses the same cab and bed as the gas F-150. Exterior designer Kenny Moore says Ford's research indicated that truck buyers wanted a pickup with "a more modern look" than today's internal-combustion models, "but not so futuristic as to be unrecognizable as a truck." That meant a few lighting changes and a couple of aerodynamic tweaks, but not so many that the Lightning doesn't read as an F-150 first and foremost. It's just an F-150 with that holy grail of truck options: lockable, weatherproof storage that doesn't take up cab or bed space.

"It's revolutionary, right? This is a space [truck owners] never had before," says Nancy Reppenhagen, who led the development of the Lightning's front trunk. Reppenhagen and her team looked at other EV cargo areas and adapted what they found to meet a truck buyer's expectations. "We saw a lot of carpeting and soft trim, which obviously weren't ideal for a truck. We chose function, which I also think is beautiful." As more electric vehicles enter the market, their different design parameters may make us all redefine what makes a car beautiful.

EV of the YEAR

Welcome to the New Frontier

Battery prices continue to drop, multiple nationwide fast-charging networks exist, and the world's largest automakers are finally building electric vehicles that you might want to buy not out of guilt or a sense of moral obligation, but because they're truly desirable. The time has come: Electric vehicles are primed to go mainstream.

Despite this progress, the electric frontier is still a wild, orderless place. There are four different plugs in play. The patchwork public infrastructure is littered with broken or painfully slow equipment and has vast dead zones if you stray too far from major interstates. And while we look

BY THE EDITORS ~ ILLUSTRATION BY TAVIS COBURN

YEAR

forward to the day when we can write about a new EV without dwelling on its range, many new models still can't clear 200 miles on the highway.

To make sense of this transition period, we rounded up all the EVs we could get our hands on and put them through instrumented testing, subjective evaluation, and side-by-side comparisons. We measured real-world range with our 75-mph highway test and plugged into DC fast-chargers to see how quickly today's EVs can refuel. We staged a 1000-mile rally to find out how those two factors would come together on a road trip. Closer to home, we drove back roads and city streets and poked touchscreens and dash covers. Then we compared our impressions and cast our votes to determine the best.

We picked our winner based on the same criteria we use to decide *Car and Driver*'s 10Best awards. Our EV of the Year is an excellent value, fun to drive, and better at fulfilling its purpose than any other vehicle in its class. To those guiding principles, we added a fourth factor: At this critical moment, our EV of the Year should advance the state of the art. That could mean raising the bar on driving range, lowering the price of entry in a segment, or delivering more driver engagement than the competition. However that manifests, the year's best electric car needs to make EVs more enticing to drivers.

After testing 11 vehicles over three weeks, we can confirm that automakers are pushing into new territory. In terms of both practicality and entertainment value, today's best EVs are capable of serving as your only vehicle if you do a little planning. And one EV is more qualified than all the others. But first, in no particular order, the competition . . .

PHOTOGRAPH BY MARC URBANO

EV of the YEAR

The Electric Kool-Aid Acid Test

Either the **Tesla Model 3 Performance** will get you hyped about EVs or nothing will.

If Tesla has proved anything, it's that electric cars don't have to be boring. The Model 3 Performance has the power, tires, and brakes of a proper sports sedan, and it can set your pulse racing as fast as any gas-powered four-door.

Not a believer? Floor it from a stop. Now try a few 30-to-50-mph pulls. This is a car that flirts with 1.00 g both on the skidpad, with a 0.96-g effort, and in its acceleration, where it punches the gut like Tyson in the '80s. It blasts to 60 mph in 3.1 seconds, with an instant response and all-wheel-drive traction that give it an off-the-line advantage over the 760-hp Ford Mustang Shelby GT500.

It'll go sideways too. In Track mode, the driver can adjust the torque split to favor the rear wheels (or the fronts). Also, the Performance model allows the driver to do something other Teslas won't: completely disable stability control. The Model 3's small-diameter steering wheel is direct and precise, creating a sense of lightness that's unusual among EVs. Hustling the 3 Performance down a ribbon of asphalt triggers an endorphin rush, but road noise and the electric motors' subdued whir leave your ears wanting. Our eyes were also left wanting when they noticed the large gap around the hood of our test car, a too-common Tesla build-quality issue.

The Numbers

Base: $58,190
As Tested: $66,190
Front Motor: induction AC, 176 hp
Rear Motor: permanent-magnet synchronous AC, 255 hp
Battery Pack: liquid-cooled lithium-ion, 81.0 kWh (*C/D* est)
Onboard Charger: 11.5 kW
Transmissions: direct-drive
Curb Weight: 4072 lb
***C/D* Test Results**
60 mph: 3.1 sec
1/4-Mile: 11.6 sec @ 115 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (mfr's claim): 162 mph
Braking, 70–0 mph: 147 ft
Roadholding, 300-ft Skidpad: 0.96 g
EPA Fuel Economy
• **Comb:** 116 MPGe
• **Range:** 310 mi

Tesla's rethinking of norms is equal parts brilliant and confounding. That big touchscreen combined with the company's vast Supercharger network makes finding a place to top up a low-stress affair. But tapping a glass screen to activate the windshield wipers will never make sense, no matter how many times we do it.

The EPA estimates the 3 Performance will travel up to 310 miles on a charge. In our 75-mph real-world test, however, Teslas tend to miss their window-sticker numbers by larger margins than most EVs. We achieved 220 miles in our range run—still a strong showing, but those fuddy legacy automakers are starting to bridge Tesla's moat.

The Model 3 Performance is a glimpse into the future of electric cars, and we like what we see. At an as-tested $66,190, the Model 3 costs less than other high-powered sports sedans such as the BMW M3 and Mercedes-AMG C63. But those gas burners offer a more emotional, if less quick, experience. Tesla will drive the final nail in the coffin of internal combustion when it figures out how to make the EV driving experience as gratifying as that of a hot-rod sedan, including the sounds. If the turn signals can be programmed to make fart noises, we don't think we're asking for too much. —*Connor Hoffman*

PHOTOGRAPHY BY ANDI HEDRICK

The People's Other Car

Aimed at the heartland, the **Volkswagen ID.4** could use a little more heart.

Volkswagen could have gone full GTI with its battery-powered ID.4. Instead, it went for mass-market appeal, building a comfortable EV with a 250-mile EPA range and a fair price. Aimed at compact-crossover buyers who want to take the leap to electric, the ID.4 has the size and shape, if not quite the height, of top-selling gas-powered utes such as the Honda CR-V and Toyota RAV4. Look past the slow-for-an-EV acceleration offered by the ID.4's 201-hp motor and you find a good small SUV with practicality, a smooth ride, and a quiet demeanor.

Inside, the ID.4 has a familial resemblance to other Volkswagens, but it's sprinkled with enough ultramodern touches to feel special, if a little annoying. Seriously, VW, you couldn't give the driver dedicated switches for the rear windows?

Like the three-row Atlas and the big, sensible Passat, the ID.4 smacks of a German brand trying to satisfy what it thinks are American tastes. If this leaves you a bit cold, help is on the way. A more powerful ID.4 with a second motor and all-wheel drive is coming soon.
–Drew Dorian

The Numbers

Base: $41,190
As Tested: $45,190
Motor: permanent-magnet synchronous AC, 201 hp, 229 lb-ft
Battery Pack: liquid-cooled lithium-ion, 77.0 kWh
Onboard Charger: 11.0 kW
Transmission: direct-drive
Curb Weight: 4700 lb
***C/D* Test Results**
60 mph: 7.6 sec
1/4-Mile: 16.0 sec @ 86 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 101 mph
Braking, 70–0 mph: 168 ft
Roadholding, 300-ft Skidpad: 0.85 g
EPA Fuel Economy
- **Comb:** 97 MPGe
- **Range:** 250 mi

Simple Machine

The **Polestar 2** strips the idea of a car down to the basics.

If EVs are our future, Volvo spinoff Polestar takes a guarded approach to what's next. Its 2 seemingly draws from modernist architecture, with a palette dominated by gray tones reminiscent of concrete and steel. Exterior styling is restrained and free of gimmicks. This is essentially tomorrow's Volvo.

The Android-based infotainment system featuring a voice-activated Google Assistant is simple to operate, and the most commonly used touchscreen controls are easy to find.

Our test car's adjustable Öhlins dampers refine the ride, but the 2 will change from laid-back city commuter to eager corner carver when asked. Ample punch from the 408-hp electric motors rockets the car to 60 mph in 4.1 seconds. However, the 200-mile range we recorded in our 75-mph test can't match the segment's top end. By combining otherwise strong performance with clean design, Polestar offers a practical alternative to its more audacious electric competitors.
–Connor Hoffman

The Numbers

Base: $61,200
As Tested: $66,200
Front Motor: permanent-magnet synchronous AC, 204 hp, 243 lb-ft
Rear Motor: permanent-magnet synchronous AC, 204 hp, 243 lb-ft
Combined Power: 408 hp
Combined Torque: 487 lb-ft
Battery Pack: liquid-cooled lithium-ion, 75.0 kWh
Onboard Charger: 11.0 kW
Transmissions: direct-drive
Curb Weight: 4714 lb
***C/D* Test Results**
60 mph: 4.1 sec
1/4-Mile: 12.7 sec @ 109 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 125 mph
Braking, 70–0 mph: 157 ft
Roadholding, 300-ft Skidpad: 0.90 g
EPA Fuel Economy
- **Comb:** 92 MPGe
- **Range:** 233 mi

The OG EV

The **Nissan Leaf Plus** falls to the competition.

A decade ago, the Nissan Leaf emerged as the first affordable EV of the modern era. Intense competition has since rendered it more of a relic than a trailblazer. Even a major 2017 redesign that brought more horsepower and range with larger battery packs didn't help.

With a 215-mile EPA range, the most powerful Leaf falls short of the Chevrolet Bolt, Kia Niro EV, Tesla Model 3, and Volkswagen ID.4, all of which have CCS fast-charging ports. Plugs for the Leaf's CHAdeMO connection are harder to find in the wild. The system also struggles to restore electrons at the advertised rate.

In top SL Plus guise, the Leaf is a heady $44,920, a mere $905 less than a similarly optioned Niro EV, only $270 below the ID.4 1st Edition, and—gulp—$3730 more than the standard-range Model 3. The cheapest big-battery Leaf, at $39,220, makes a lot more sense. Once a pioneer, this EV needs a price cut or a redesign (or both) to carve out space to survive.
—Maxwell B. Mortimer

The Numbers

Base: $39,220
As Tested: $45,705
Motor: permanent-magnet synchronous AC, 214 hp, 250 lb-ft
Battery Pack: liquid-cooled lithium-ion, 59.0 kWh (*C/D* est)
Onboard Charger: 6.6 kW
Transmission: direct-drive
Curb Weight: 3933 lb
***C/D* Test Results**
60 mph: 6.7 sec
1/4-Mile: 15.4 sec @ 91 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 101 mph
Braking, 70–0 mph: 184 ft
Roadholding, 300-ft Skidpad: 0.78 g
EPA Fuel Economy
- **Comb:** 104 MPGe
- **Range:** 215 mi

Y, Though?

A sloppily built **Tesla Model Y Performance** leaves us wondering what all the fuss is about.

Why do so many adjustments in Tesla's Model Y require twice the number of steps we're used to? Why is the charging plug different from what all other automakers use? Why is the Y so much worse than the Model 3?

Every Tesla provokes a few head-scratchers, but this particular Model Y Performance left us flummoxed. If you drive the 3 and the Y back to back, you'll find little to convince you they share a platform. Where the 3 is smooth, the Y jerks. This may seem harsh, just like this Tesla's ride, but it didn't help that the infotainment system on the Y we tested stopped working within 12 hours of the car's arrival. Sloppy fit and finish and a grating squeak coming from the right rear seat were reminders that no two Teslas are identical.

Why is the Model Y so popular, then? In Performance trim, it will launch to 60 mph in 3.6 seconds, and the small-diameter steering wheel requires a firm hand, creating the illusion of sport. The real appeal is more rational, though. Cruising at 75 mph, the Y can go 230 miles between plug-ins, and buyers have access to a second-to-none DC fast-charger network that gives this EV the legs to be someone's only car. But between Electrify America's growing charging network and the long-range EVs from Ford and Volkswagen, there's no longer a reason why Tesla should own this segment.
—K.C. Colwell

The Numbers

Base: $61,190
As Tested: $72,190
Front Motor: induction AC, 178 hp
Rear Motor: permanent-magnet synchronous AC, 240 hp
Battery Pack: liquid-cooled lithium-ion, 81.0 kWh (*C/D* est)
Onboard Charger: 11.5 kW
Transmissions: direct-drive
Curb Weight: 4439 lb
***C/D* Test Results**
60 mph: 3.6 sec
1/4-Mile: 12.1 sec @ 113 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (mfr's claim): 155 mph
Braking, 70–0 mph: 154 ft
Roadholding, 300-ft Skidpad: 0.94 g
EPA Fuel Economy
- **Comb:** 111 MPGe
- **Range:** 291 mi

TESLA PHOTOGRAPH BY MARC URBANO, NISSAN PHOTOGRAPH BY ANDI HEDRICK

Fast Knowledge

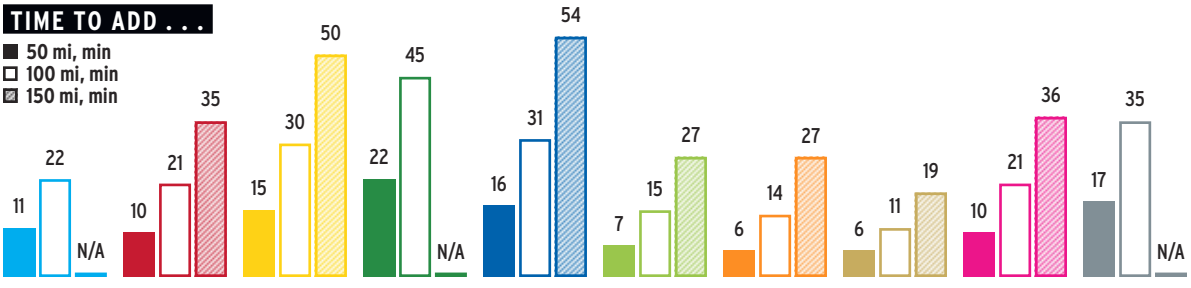
What's best: an EV that charges from 5 to 80 percent in 25 minutes, one that charges at a peak power of 270 kilowatts, or one that adds 200 miles of range in 30 minutes? Automakers don't make it easy to compare how quickly their EVs can charge.

We can help. For this test, we charged each vehicle's battery from 10 to 90 percent capacity on the fastest equipment available to us. (Due to a compatibility issue with some Electrify America DC fast-chargers, the Polestar 2 and Volvo XC40 Recharge were charged on equipment that couldn't deliver electricity at the vehicles' claimed max power. We also didn't test the Model Y because of its similarity to the Model 3.) Then we used each vehicle's consumption from our 75-mph highway test to calculate how quickly the DC fast-charging added miles of range, shown below. We've also included data on charging power (reported in kilowatts) to illustrate that judging a vehicle by the max rating can be misleading; the average power can be less than half of those headline figures.

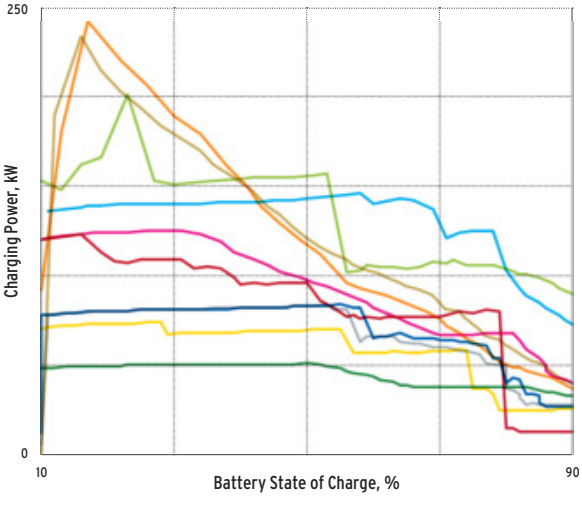
So who wins? That depends on which charging metric you think matters most. The Audi e-tron averages the highest power, but inefficiencies on the road mean it needs more electricity for every mile of range added. The Tesla Model S Long Range Plus takes first place where it counts: adding the most miles in the shortest period. It pumps 100 miles of 75-mph highway driving in just 11 minutes.

Audi e-tron · Ford Mustang Mach-E 4X · Kia Niro EV · Nissan Leaf Plus · Polestar 2 · Porsche Taycan 4S PBP · Tesla Model 3 Performance · Tesla Model S Long Range Plus · Volkswagen ID.4 · Volvo XC40 Recharge

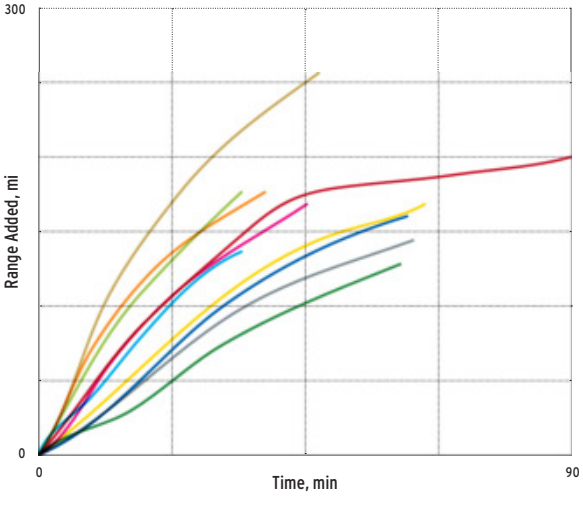
TIME TO ADD . . .



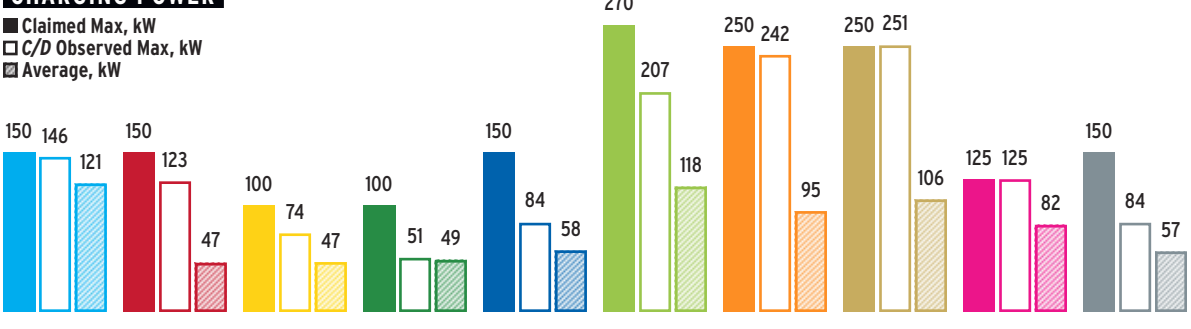
CHARGING POWER VS. STATE OF CHARGE



MILES ADDED VS. TIME



CHARGING POWER



The Sleeper

More capable than it appears, the **Kia Niro EV** is too often overlooked.

The Kia Niro EV reinforces some negative stereotypes about electric cars. At a glance, its dorky looks make it barely more appealing than a golf cart, and its economy-grade cabin materials don't live up to the price (our loaded EX Premium test car stickered for $47,145). But unlike in the bad old days of EVs, we have a car whose merits lie in its powertrain, with the Niro shattering preconceived notions about small EVs being slow and having limited range. A 201-hp electric motor gets the little box to 60 mph in a swift 6.2 seconds, and there's enough torque to spin the tires. Plus, the car's 64.0-kWh battery pack and impressive efficiency allowed it to go 210 miles in our 75-mph highway test, beating the range of several more expensive EVs.

We also like how the Niro goes down the road. The steering feels right, and the ride is reassuringly firm. What the interior lacks in luxury is made up for in practicality; the infotainment system is easy to use, and the back seat and cargo area are spacious. With the right incentives or a price closer to the base EX's $40,265, this Kia would be a prime choice in the affordable-EV world.

–Joey Capparella

The Numbers

Base: $40,265
As Tested: $47,145
Motor: permanent-magnet synchronous AC, 201 hp, 291 lb-ft
Battery Pack: liquid-cooled lithium-ion, 64.0 kWh
Onboard Charger: 7.2 kW
Transmission: direct-drive
Curb Weight: 3915 lb
***C/D* Test Results**
60 mph: 6.2 sec
1/4-Mile: 14.9 sec @ 94 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 107 mph
Braking, 70–0 mph: 176 ft
Roadholding, 300-ft Skidpad: 0.88 g
EPA Fuel Economy
- **Comb:** 112 MPGe
- **Range:** 239 mi

Quiet Progress

The **Audi e-tron** doesn't look like a vision of the future, but maybe that's the point.

Besides its robotic name, there's little to suggest the Audi e-tron portends the future. Sure, this 402-hp electric SUV literally sounds like something Han Solo would pilot. But the e-tron and its swoopy-roof Sportback counterpart could be mistaken for other Audis in a parking lot.

The conventional design, which includes a palatial cabin, should make the switch to electric a bit easier for some, although new EV customers might want more than the e-tron's 222 miles of estimated range. In our 75-mph highway test, the Audi went just 170 miles before needing a recharge. However, in our fast-charging test, it sucked down electricity faster than any other EV, although some more efficient cars were able to add driving miles quicker.

The 5.2-second run to 60 isn't terribly impressive for an $87,440 vehicle, and if one-pedal driving is your bag, the Audi won't regen aggressively enough for you. But the build quality, handsome appointments, and tranquil driving experience are worthy of attention. More traditional than trendy, the e-tron is designed to be unthreateningly familiar.

–Eric Stafford

The Numbers

Base: $66,995
As Tested: $87,440
Front Motor: induction AC, 184 hp, 228 lb-ft
Rear Motor: induction AC, 224 hp, 262 lb-ft
Combined Power: 402 hp
Combined Torque: 490 lb-ft
Battery Pack: liquid-cooled lithium-ion, 86.5 kWh
Onboard Charger: 9.6 kW
Transmissions: direct-drive
Curb Weight: 5856 lb
***C/D* Test Results**
60 mph: 5.2 sec
1/4-Mile: 13.8 sec @ 101 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (mfr's claim): 124 mph
Braking, 70–0 mph: 181 ft
Roadholding, 300-ft Skidpad: 0.85 g
EPA Fuel Economy
- **Comb:** 78 MPGe
- **Range:** 222 mi

AUDI AND PORSCHE PHOTOGRAPHY BY MARC URBANO, KIA PHOTOGRAPH BY ANDI HEDRICK

Here's Why We Didn't Include That One EV You Believe Should Have Won It All

For this inaugural test, we intended to evaluate every EV that's currently on the market. If a vehicle's not here, you can safely assume it wasn't available. While several highly anticipated models hadn't launched in time for our April event (e.g., the GMC Hummer EV and BMW i4), some absences warrant explanation.

Jaguar says it will sell only electric vehicles starting in 2025, and General Motors aims to do the same by 2035. Yet neither made its current EVs available to us. Why? Jaguar simply declined to send an I-Pace, a decision we're still puzzled by. Chevrolet, which let us drive its new Bolt EUV a month earlier, said it didn't have the engineering signoffs to allow a car out of its sight for three weeks. The refreshed 2022 Bolt EV (which is slightly smaller than the Bolt EUV) was also unavailable, and Chevy didn't want to send a 2021 model.

The story was similar at Hyundai. Since the refreshed 2022 model wasn't yet out, the company chose not to field a Kona Electric. A rep also told us that Hyundai didn't want to provide an Ioniq with the Ioniq 5 so close to market. BMW and Mini kept their respective 153-mile i3s and 110-mile Cooper SE parked, presumably spooked by the prospect of how they would perform on a 1000-mile road trip. Audi and Porsche had only Europe-spec models of the e-tron GT and Taycan Cross Turismo in the United States and wouldn't hand either of them over for extended testing.

Tesla, which disbanded its PR department in 2020, didn't provide a single vehicle. Instead, we rented the Model 3, S, and Y from private owners for this test, and we decided to skip the slow-selling, expensive Model X. We also reached out to startups that are hoping to replicate Tesla's success. Rivian, Bollinger, Lordstown, and Lucid all said their EVs weren't ready for our scrutineering. Maybe next year.

Transcending Electrons

The **Porsche Taycan 4S Performance Battery Plus** isn't a typical electric vehicle.

Numbers don't tell the full story of the Taycan 4S, the midrange model of Porsche's EV. Initial expectations are tempered by a steep $105,150 starting price and a hulking 5128-pound curb weight. The 3.4-second time to 60 mph from its 562-hp dual-motor, all-wheel-drive setup is quick but hardly stands out next to the 2.4-second run from the 750-hp Taycan Turbo S. Even our test car's optional 83.7-kWh battery, which ups the base ask to $111,730, earns it only a modest 227-mile range estimate from the EPA. (That said, in our hands, and thanks in large part to its unique two-speed transmission, it pulled off the impressive feat of nearly matching that number in the real world, covering 220 miles while cruising at 75 mph.) No, to appreciate the Taycan 4S, you must disregard the specs and just drive it.

Between its talkative, perfectly weighted helm and the way its controls cocoon the excellent driving position, the Taycan's essence revolves around its pilot, bringing a rich sense of over-the-road intimacy. Though not insanely rapid, the Taycan 4S is invigorating and maintains a few welcome ties to conventional sports sedans. The two-speed automatic on the rear axle provides a satisfying upshift. The bulk of the car's regenerative braking is activated via the brake pedal, rather than from just letting off the accelerator, which means you exercise the left pedal as you would in an internal-combustion vehicle. An available whirring sci-fi soundtrack adds excitement to the quiet act of electric motoring; some may like the effect more than others.

Porsche charges handsomely for the 4S's optional rear-axle steering, active anti-roll bars, and carbon-ceramic brakes, but the resulting sports-car-like grip (1.03 g's) and braking ability (147 feet from 70 mph) are as impressive as the car's unflappable composure and comfortable ride. As a transportation device, a Tesla Model S—the Taycan's chief rival—will take you farther on a charge and accelerate just as quickly for significantly less money. But the harmony in which the Taycan 4S's performance, refinement, and style come together on the road means it's more than an electrified conveyance. Beyond the badge on its nose, this is what makes it a Porsche. —*Mike Sutton*

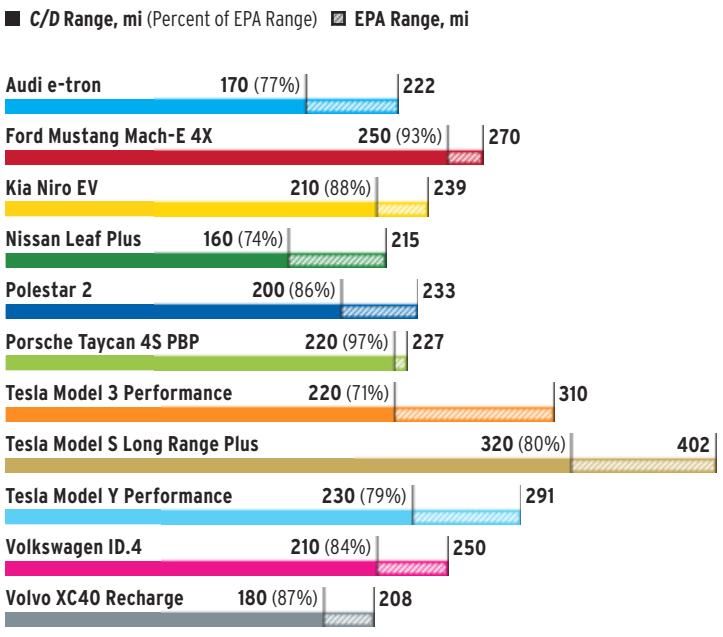
The Numbers

Base: $111,730
As Tested: $143,690
Front Motor: permanent-magnet synchronous AC
Rear Motor: permanent-magnet synchronous AC
Combined Power: 562 hp
Combined Torque: 479 lb-ft
Battery Pack: liquid-cooled lithium-ion, 83.7 kWh
Onboard Charger: 11.0 kW
Transmissions, F/R: direct-drive/2-speed automatic
Curb Weight: 5128 lb
***C/D* Test Results**
60 mph: 3.4 sec
1/4-Mile: 11.7 sec @ 120 mph
Results above omit 1-ft rollout of 0.2 sec.
Top Speed (gov ltd): 155 mph
Braking, 70–0 mph: 147 ft
Roadholding, 300-ft Skidpad: 1.03 g
EPA Fuel Economy
- **Comb:** 77 MPGe
- **Range:** 227 mi

Range Finder

Before you set off on your first EV road trip, there's something you need to understand about range figures. EPA estimates, which automakers use in their marketing, are based on testing that mimics city, suburban, and highway driving. If you jump on an actual interstate and expect to match the number on the window sticker, you'll probably coast to a stop well short of your destination. To help buyers know what to expect on a long-distance highway drive at grown-up speeds, *Car and Driver*'s real-world range test is conducted at 75 mph.

Due primarily to the aerodynamic drag at that speed, most EVs underperform their EPA estimates. The 11 here missed their window-sticker figures by an average of 17 percent. Tesla has mastered scoring big range on the government test, but its advantage isn't as big in the real world as the EPA suggests. Its cars have a worse-than-average delta between advertised numbers and our results.



Power Up

The **Volvo XC40 Recharge** is a better small SUV, but it's not a better EV.

If you drive the XC40 Recharge while wearing headphones playing the buzz and hum of a four-banger, you could make yourself believe you're driving the gas version of Volvo's blocky crossover. Gas- and battery-powered XC40s are similar, sharing interior and exterior designs and even a flinty ride. But instead of a turbo four, the Recharge has two electric motors.

The difference between the powertrains is obvious when you pass a left-lane dawdler or pull away from a stoplight. While the gas-powered XC40 tops out at 248 horsepower, the EV version has an eager 402 horses, needs a mere 4.3 seconds to leap to 60 mph, and scoots from 50 to 70 mph in 2.2 seconds.

The Recharge's effortless quickness helps justify its $55,085 base price, but its 75.0-kWh battery pack is good for only 208 miles between charges, according to the EPA. At a steady 75 mph, you'll need to plug in after 180 miles. Luckily, thanks to an upgraded infotainment system that employs easy-to-use Google software with voice recognition, finding a charging station is as easy as saying, "Hey, Google, find a charging station."

This SUV's problem is that Tesla sells a Model Y that costs less and goes farther. Volvo's EV may be more fun to drive than a gas XC40, but without more range, it isn't much of a threat to Tesla.
–Annie White

PHOTOGRAPHY BY MARC URBANO

The Numbers

Base: $55,085
As Tested: $59,780
Front Motor: permanent-magnet synchronous AC, 201 hp, 243 lb-ft
Rear Motor: permanent-magnet synchronous AC, 201 hp, 243 lb-ft
Combined Power: 402 hp
Combined Torque: 486 lb-ft
Battery Pack: liquid-cooled lithium-ion, 75.0 kWh
Onboard Charger: 11.0 kW
Transmissions: direct-drive
Curb Weight: 4791 lb
C/D Test Results
60 mph: 4.3 sec
1/4-Mile: 12.9 sec @ 108 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 113 mph
Braking, 70–0 mph: 171 ft
Roadholding, 300-ft Skidpad: 0.84 g
EPA Fuel Economy
- **Comb:** 79 MPGe
- **Range:** 208 mi

Enduring Persistence

Hiding its age well, the **Tesla Model S Long Range Plus** manages to stay out in front, most of the time.

In the world of new cars, going a decade without a complete overhaul is a near guarantee of obsolescence. So how has the Model S endured? Starting as a trendsetter—both in range and in instigating today's mania for ever-larger infotainment screens—certainly helps. Thanks to a steady stream of improvements, the Model S has remained at the front of the pack in terms of its ability to cover miles.

For this test, we wrangled the Long Range Plus variant, the first EV to crest 400 miles on a charge according to the EPA's methodology. With a 20 percent range boost over the 2018 100D, this Model S is also the current champ of our 75-mph highway test and the only EV in the 300s, at 320 miles. Available for only the 2020 and 2021 model years, the Long Range Plus features a number of enhancements over earlier Model S iterations. An electric oil pump replaces a mechanical unit on the rear motor, the battery pack holds about 3 percent more energy, and Tesla claims that gearbox improvements and a new aerodynamic wheel design boost range by 2 percent each.

It still drives with the verve of a competent luxury sedan, even with efficiency-minded all-season tires. Although this is the slowest Model S, the hearty shove on tap and its 3.5-second sprint to 60 mph are anything but.

The price of the S has been plummeting apace with the range gains. Three years ago, if you wanted the longest-range Model S, you had to shell out at least $97,200. Tesla has since knocked that down by more than $25,000, to $70,620 for the Long Range Plus. However, on the facelifted S that's launching this year, the Long Range variant will replace the Plus as the base offering and kick the ask back up to $81,190.

A front-motor failure sidelined our 3600-mile car in the middle of testing. The owner begged his way into an overbooked Tesla service center, which swapped in a new motor just in time for our 1000-mile road trip, but the Model S's fate was already sealed. We couldn't consciously name the Model S our EV of the Year when, almost a decade on, Tesla is still building cars with these problems. —*Dave VanderWerp*

The Numbers

Base: $70,620
As Tested: $70,620
Front Motor: permanent-magnet synchronous AC, 275 hp, 310 lb-ft
Rear Motor: induction AC, 282 hp, 247 lb-ft
Battery Pack: liquid-cooled lithium-ion, 104.0 kWh (*C/D* est)
Onboard Charger: 11.5 kW
Transmissions: direct-drive
Curb Weight: 4824 lb

***C/D* Test Results**
60 mph: 3.5 sec
1/4-Mile: 11.9 sec @ 116 mph
Results above omit 1-ft rollout of 0.2 sec.
Top Speed (gov ltd): 159 mph
Braking, 70–0 mph: 172 ft
Roadholding, 300-ft Skidpad: 0.86 g

EPA Fuel Economy
- **Comb:** 117 MPGe
- **Range:** 402 mi

EV of the YEAR

The Prophet

Foreshadowing a future when an EV's range is secondary to how it drives, the Ford Mustang Mach-E is our EV of the Year.

By Eric Tingwall ~ Photography by Marc Urbano

If an automaker wanted to convert people from EV skeptics to EV evangelists, it's hard to imagine a better vehicle for the job than the Ford Mustang Mach-E. It arrives in the familiar shape and size of the crossovers Americans love, at a price that competes with gas-powered alternatives, and with a design that gets noticed. The Mach-E has the range and charging speed to wave off the most common EV criticisms, and thanks to Electrify America's recent work, there's a nationwide charging network that makes long interstate trips not just possible but tolerable. For new EV converts, piloting a Mach-E isn't so different from driving a gas-burning SUV that it feels foreign, yet the experience is futuristic enough to be exciting. It's the right car to bring drivers along during this watershed moment as EVs transition from niche alternative to new normal.

Best of all, the Mach-E is fun. It moves us past the argument that we should drive EVs because they're better for the environment and proposes a simpler, more fundamental truth: EVs can be as rewarding to drive as their gas counterparts. The Mach-E strikes a sweet balance between practical and visceral, landing in the space where Mazda often operates. Ford has built an EV that's suited to kid-hauling duty, Costco runs, and daily commutes but that doesn't strip the soul out of driving.

YEA

The Numbers

Base: $56,400
As Tested: $56,800
Front Motor: permanent-magnet synchronous AC
Rear Motor: permanent-magnet synchronous AC
Combined Power: 346 hp
Combined Torque: 428 lb-ft
Transmissions: direct-drive
Battery Pack: liquid-cooled lithium-ion, 88.0 kWh
Onboard Charger: 10.5 kW
Curb Weight: 4838 lb
***C/D* Test Results**
60 mph: 4.9 sec
1/4-Mile: 13.6 sec @ 103 mph
Results above omit 1-ft rollout of 0.3 sec.
Top Speed (gov ltd): 114 mph
Braking, 70–0 mph: 177 ft
Roadholding, 300-ft Skidpad: 0.82 g
EPA Fuel Economy
- **Comb:** 90 MPGe
- **Range:** 270 mi

You don't attack a road in this Mustang. You set a swift pace and find flow in a seamless plateau of torque as you transition between foot-to-the-floor acceleration and the precise modulation of regenerative braking during one-pedal driving. The all-wheel-drive, big-battery version makes 346 horsepower and hits 60 mph in 4.9 seconds. On city streets, tapping into that power is exhilarating. The Mach-E punches out of 25-mph corners and zaps past dawdling delivery trucks. Thrust arrives as fast as your foot can ask for it.

Ford adds drama with a synthetic soundtrack of a big-engine burble that's been smoothed into a warble. The piped-in audio doesn't read like a combustion engine and isn't exactly the stuff of science fiction either. But based on how many of our drivers were content to keep the sound enabled, it appears that Ford has come the closest of any automaker to figuring out what an EV should sound like.

Unlike so many nose-heavy gas-powered competitors, this family crossover is surprisingly neutral if you push the speed in corners, and quick steering places the Mach-E exactly where you want it. Ballasted by the 88.0-kWh battery pack under the floor, the body stays flat and passengers remain upright as the car swings around bends feeling as planted as a hundred-year-old oak tree. On Michigan's nastiest roads, though, the Mach-E bounces in a way that reminds us of other Mustangs, both the two-door and four-legged varieties. Ride quality is the one aspect where this Ford sometimes left us wanting.

The Mach-E sails down a 70-mph highway with remarkable isolation. To passengers, the outside world sounds like a 68-decibel breeze. The seats are supremely comfortable, and the driving position neatly splits the difference between car and crossover. You sit relatively high at the elevated vantage that so many buyers want, yet your legs stretch out in front of you, as in a car, thanks to the underfloor battery. Back-seat space is generous, and the deep cargo hold is roomy despite the fastback roofline.

Ford clearly borrowed a few ideas from Tesla: panoramic fixed-glass roof, unconventional door handles, vertically oriented center display. While these highlights aren't particularly original, Ford managed to make the cabin design feel fresh without resorting to gimmicks or trying to pass off cost-cutting measures as innovation the way Tesla does. And unlike in, say, a Model Y, there's no learning curve for driving a Mach-E. The gear selector doesn't double as the cruise-control switch, like it does in Teslas. There's a simple instrument cluster in the driver's line of sight. And if we have to live with touchscreens in our cars, they all should be this huge. The Mach-E's 15.5-inch screen supersizes the virtual buttons so they're easy to peck at, and the interface is logically laid out.

All of these strengths would be moot if the Mach-E didn't have the range to go long. According to the EPA estimate, the Ford is good for 270 miles on a full charge, and at a constant 75 mph in our hands, it came just 20 miles shy of that figure. In *Car and Driver*'s range testing, only the Tesla Model S has covered more ground. Not coincidentally, the Model S is the sole EV currently for sale with a larger battery.

The Mustang Mach-E starts at $43,995, a couple of thousand above the average transaction price of a new vehicle, although the federal tax credit can take $7500 off that sting, for now. The more powerful, longer-range, all-wheel-drive version that we drove opens at $56,400. Even at that price, the Ford has the premium materials and build quality to make the more expensive luxury cars in this year's EV test look like rip-offs.

One key requirement for our EV of the Year—in addition to fun, value, and mission fulfillment—is that it make electric vehicles more desirable to buyers to a degree that moves the industry forward. That's where the Mach-E stands out from the 10 other vehicles we evaluated. At long last, an automaker has given us an EV that competes head to head with Tesla on design, performance, price, and range, and it neither looks nor feels like it was built in a tent. It's the perfect vehicle to rewrite preconceptions that were formed when the vast majority of EVs were too small, too slow, too expensive to buy yet too cheap to live with, and hobbled by too-short range and too-spotty public infrastructure that wouldn't allow them to venture far from home. Plus, the Mach-E has the driving dynamics and design to push new buyers past mere acceptance of EV technology to excitement.

The worst thing about the Ford Mustang Mach-E is the name, which implies a loud and rowdy machine that will have you seeing red anytime a stoplight turns green. Ford triggered our emotions and raised our expectations by calling its EV crossover a Mustang, then delivered a vehicle that's great in an entirely different way. It's as smooth and calm as cars come, with quiet dynamic competence, ample room for four, and a cabin that appears luxury-car expensive.

But if the name is our biggest gripe, that says something major about the stuff that matters. An established automaker has created a relatively affordable, long-range EV with the gotta-have-it factor of a Tesla. It's a pivotal moment as electric vehicles become far more intriguing to both mainstream buyers and enthusiasts. Even if we're still not comfortable with the idea of calling the Mach-E a Mustang, we are calling it our EV of the Year.

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THE EV 1000

A 1000-MILE RACE ACROSS FOUR STATES REVEALS WHAT IT'S LIKE TO DRIVE AN EV LONG DISTANCES IN 2021. SPOILER: IT'S POSSIBLE BUT NOT ALWAYS FUN.

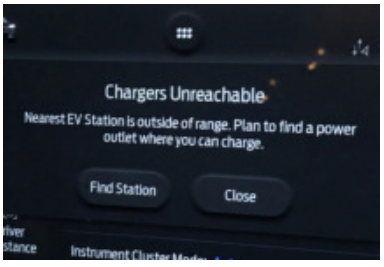
By Eric Tingwall ~ Illustration by Tim Marrs

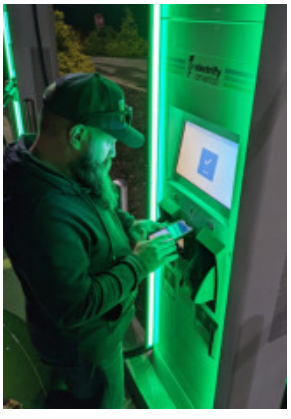
We didn't initially conceive this story as a race. But if you tell two or more *Car and Driver* editors that they need to drive from a start line to a finish line, there's no going back: You've officially sanctioned a race. Check the FIA sporting regulations.

The plan was to benchmark the state of EV technology and the nation's charging infrastructure by road-tripping EVs beyond the range of a single charge. By the time we got to the start line, we had the 11 vehicles from our EV of the Year test [see page 38] staged for a 1000-mile lap through four states, plus a name to prove that what we were about to do was twice as hardcore as the Indy 500: the EV 1000.

We did our best to keep it relatable to you, dear reader, by banning the usual hijinks: no taped-over panel gaps, no stripped interiors to shave weight, no rented U-Hauls to break the wind. The point, we said over and over, was to capture the experience of driving an EV on a long road trip, just as an owner might. Naturally, then, half the teams pumped their tires over the recommended pressure, looking for any advantage that might go unnoticed.

The drivers—22 total in teams of two—departed from Ann Arbor carrying clues about how seriously they were taking this not-a-race. Staff editor Drew Dorian, driving the Audi e-tron, brought a 50-foot extension cord. Editor-in-chief Sharon Silke Carty packed an acoustic guitar to pass the time while charging the Tesla





TO SURVIVE OUR EV ROAD TRIP, MANY STAFFERS HAD TO LEARN NEW SKILLS, SUCH AS DRIVING IN THE SLOW LANE, MAKING A BOWL OF CEREAL, AND PARKING A PORSCHE LIKE A JERK FOR AN ENTIRELY JUSTIFIED REASON.

Model Y Performance. And testing director Dave VanderWerp showed up with two Subway Footlongs. He figured that the Tesla Model S Long Range Plus he was driving would charge faster than any sandwich artist could stack cold cuts, and he wasn't planning to wait for anyone. In the final moments before the race, VanderWerp's friend and co-pilot surveyed the competition and quietly observed, "Everyone's wearing pants. That's a mistake. All of these people are going to need climate control."

Here's the thing about racing EVs in the real world: It doesn't look remotely like what goes on in Monaco or in Daytona or even in the classic Cannonballs. It looks more like racewalking, the Olympic sport where athletes hobble as fast as possible without technically running. The EV 1000 is a contest of endurance and speed, but not too much speed, because to cover big distances quickly in an EV, you have to push the pace while simultaneously holding back.

Any long-distance drive in an EV starts with a question: What are you willing to forgo to maximize your range? Drivers disabled automatic headlights and ignored cruise control. Climate control was used sparingly, if at all. And get this: Speed limits were frequently heeded.

Drivers were free to choose their own route as long as they passed through mandatory waypoints (in order) in Cincinnati; Athens, Ohio; Morgantown, West Virginia; Erie, Pennsylvania; and Ann Arbor. Most teams scouted charging locations ahead of time with A Better Routeplanner (ABRP), an EV-specific navigation website and app. Users provide info about their vehicle and intended speed so ABRP can estimate energy consumption and spit out a route with recommended stops, including the charging time needed at each one, for the fastest-possible trip. At least that's the theory.

User error almost certainly played a role, but the drivers in the Nissan Leaf insist they were following the app's guidance when they made the first pit stop—charging for all of six minutes—just 23 miles into the race. That mistake came back to haunt them when they were the last of four teams to arrive at a single ChargePoint DC fast-charger at an adult-education center near Lima, Ohio. The day's lesson: Be wary of any fast-charging station with only one unit. The Leaf squeezed electrons from a nearby lower-power Level 2 plug for 96 minutes before the fast-charger became available. The Nissan team would have been waiting longer, but the duo in the Audi had given up their spot to search for another charging station, only to return a short while later. The unit they'd hoped to use was broken.

The teams in the Tesla Model 3 and Model Y had it comparatively easy. While Tesla's built-in nav can't plot a multistop journey, setting the next waypoint directed them to fast and reliable Superchargers as necessary. Three non-Tesla teams also kept the pace based on a simple but smart strategy: Because an EV's battery replenishes faster at a lower state of charge, ideally you wait until the vehicle is nearly out of juice to plug in. The Kia Niro EV and Volkswagen ID.4 made it to a Dayton suburb for their first stops, and the Mustang Mach-E went 237 miles to the edge of Cincinnati before it had to charge.

VanderWerp, in the Model S,

There are no unimportant parts in a car. Take, for example, the piston ring—a thin piece of metal whose main purpose is to fill the gap between a piston and the cylinder wall. **Every** engine, whether it powers a multimillion-dollar race car or an affordable environmentally conscious hatchback, relies on the durability of its piston rings to function properly. They cost mere cents to make, but are just as vital as the most expensive component. It's no surprise, then, that the first company Soichiro **Honda** founded made piston rings.

Mr. Honda went on to create Honda Motor Co., Ltd., based on the philosophy that, to succeed, you must perfect the basics. This ethos **has** led Honda to build engines that are raced in nearly every level of motorsports, from go-karts to the NTT INDYCAR® SERIES. This is not simply a clever "win on Sunday, sell on Monday" marketing strategy. The close tie between Honda automobiles and Honda Performance Development™ creates a free flow of ideas and engineering know-how that benefits both our race cars and our production cars. The connection is

so strong that many of the cars we develop for **racing** competitions are based on our mass-produced cars, utilizing many of the same key engine components, from turbochargers to piston rings. This means the Honda you drive has been built with the same passion for performance that goes into our race cars.

When it comes to the NTT INDYCAR® SERIES, no other manufacturer comes close to the success of Honda: 252 victories, 17 drivers' titles, 9 manufacturers' championships, and 13 Indianapolis 500® wins. In 2023, Honda will begin racing a new 2.4-liter twin-turbocharged V-6 hybrid engine **in** the series, part of our commitment to continue our lead in performance innovation. The lessons we learn on the track will make their way into our production cars, the same way our dedication to engineering excellent automobiles makes **its** way to the track—just as Soichiro Honda intended. As a competitive racer himself, he believed in his **heart** that "racing improves the breed." It's this spirit that will keep Honda at the forefront of racing technology, perfecting the basics, even when the time of piston rings and internal combustion is far behind us.

HONDA

Chip Ganassi Racing Honda driven by NTT INDYCAR® SERIES Champion Scott Dixon. ©2021 American Honda Motor Co., Inc.

wanted to post a big number on the first leg to make a statement. Possibly that statement was "No owner would ever do this." To maximize the energy available for moving the car, he ran a radar detector off a portable battery and played music through a Bluetooth speaker. With climate control off, the cabin temperature reached 86 degrees despite a 65-degree ambient temperature. At least all the sweating meant that neither VanderWerp nor his partner needed the TravelJohn disposable urinals they'd brought. They plugged into their first Supercharger after 326 miles and were back on the road 26 minutes later.

As they skirted Cincinnati, the eight teams without access to Superchargers had decisions to make. The southern leg of the route pulled drivers off the interstate and onto two-lane highways with few fast-charging opportunities. Teams could take the relatively straight shot from Cincy to Athens, where a single 50-kW unit waited, or they could detour northeast to Columbus, adding 27 miles to the trip but also passing an Electrify America station good for up to 350 kilowatts.

Several drivers had, by this point, abandoned their prescribed plan from ABRP and instead used the PlugShare app and their own judgment to select stops. Trying to figure out how long to charge and whether you need to slow down to make your next destination requires constant calculation. Executive editor Ryan White pointed out another possible reason why Americans have been slow to adopt electric vehicles: As a people, we hate math.

In the southeast sector of our racetrack, charging options were abysmal. Seven of the eight non-Tesla EVs ended up charging in Athens, including a couple that had stopped in Columbus too. Once again, cars stacked up waiting for a single ChargePoint DC fast-charger.

In the spirit of driving as an owner might, teams were required to stop from midnight to 8:00 a.m. In Morgantown, the approaching dark period started a race within a race to claim the few plugs in the city. The Volvo XC40 Recharge scored the prime spot at a Harley-Davidson dealer next to a hotel. The Niro team found a free Level 2 station in a permit-only parking lot, figured that the charging cord locked into the port would prevent anyone from towing the car, and walked a quarter-mile to their hotel. The Audi drivers used Uber to shuttle between their charging car and a hotel. The Polestar 2, with less than 25 percent battery remaining, was left unplugged all night.

About 50 miles north of Morgantown, the Mach-E's fast start was falling apart in a spectacular string of charging failures. An EVgo station refused to work for more than a minute at a time, eating up a half-hour before the drivers moved on. With 6 percent battery charge, the Mach-E crawled 10 miles to another EVgo unit and had the same problem. The team then crossed the street and hooked up to a Level 2 station.

Yeah, watching paint dry is boring, but have you ever watched an electric car charge? The Mach-E added 12 miles of range in 50 minutes, which is exactly how long the drivers' patience lasted. With the car showing just 24 miles of predicted range, the Mach-E team gambled on making it to the Electrify America location 30 miles away.

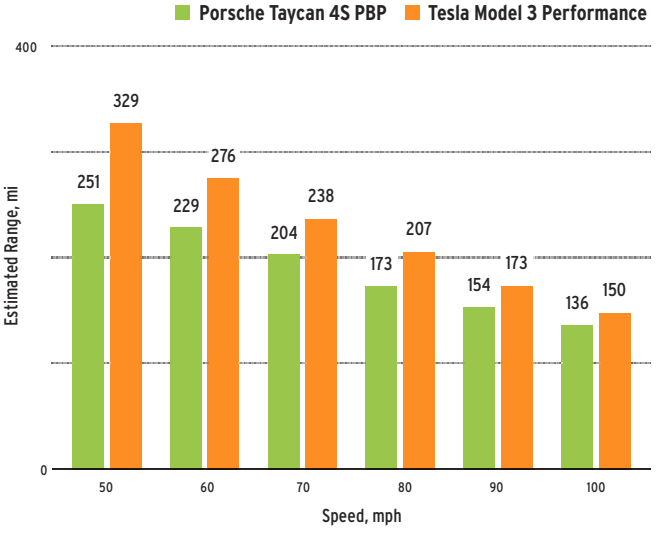
Climbing the energy-sapping hills surrounding Pittsburgh, the Ford began projecting its own range anxiety onto the occupants. First, the car told the driver to find a different, closer charging station. Then it warned that the car wouldn't make it to any public charging station, and the pop-up message advised the driver to find any available outlet to plug into. Finally, the computer gave in to despair and told the driver to pull over.

The driver (the author of this tale) kept his foot in it—at least enough to hold 50 mph on a 55-mph highway—and arrived at the Electrify America station with the instrument cluster showing zero

SPEED VS. RANGE

Speedy Decline

When it comes to EVs, the answer to "What's its range?" is heavily dependent on a vehicle's speed. That's because the force required to push through the atmosphere increases exponentially with speed, and unlike gas vehicles, EVs typically lack a multigear transmission to keep the propulsion source spinning in its most efficient zone. To quantify how range drops off, we recorded the indicated consumption of the Porsche Taycan 4S and Tesla Model 3 at various speeds. We then translated those figures into range. The Taycan's range declines more slowly with speed than the Model 3's, likely in part because of the novel two-speed transmission bolted to the Porsche's rear motor.



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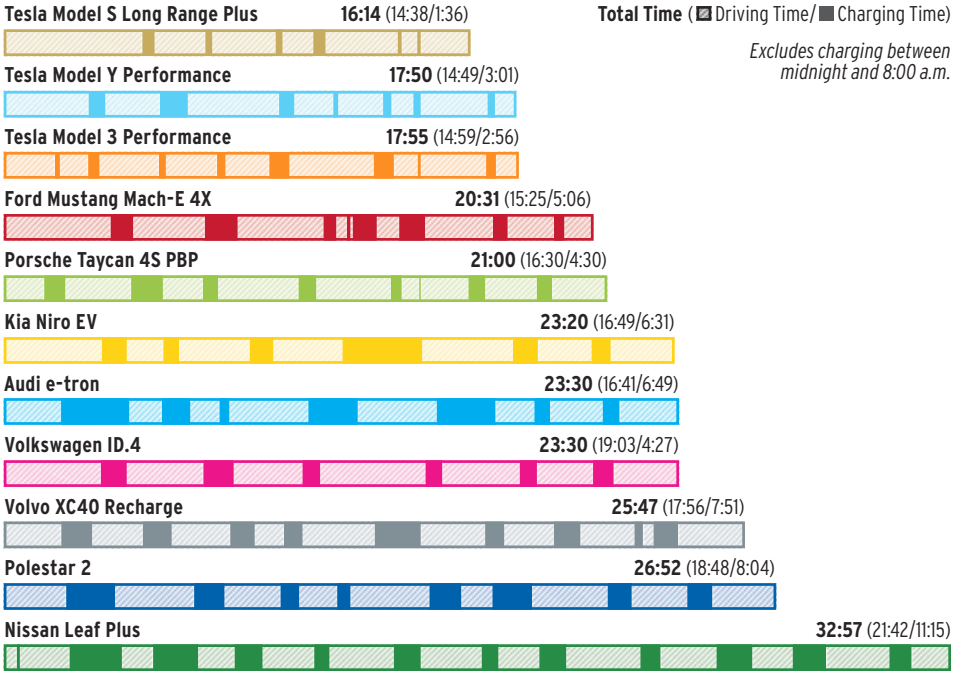
DRIVING VS. CHARGING

On the Clock

To keep our drivers honest, we followed their moves and logged their charging time with Geotab GO GPS trackers. This chart shows when each team stopped to charge. The slowest three had to travel out of their way to hunt for suitable charging locations.



range and no battery charge. For the drivers, the moment of relief was soon eclipsed by the disappointing realization that, having squandered nearly two hours, they had also lost any chance of beating a Tesla.

The Model 3 and Model Y ended the day at the same hotel in northeastern Ohio. Technical editor David Beard, who drove the Porsche Taycan 4S like he'd entered the original Cannonball, made it to Pittsburgh, with the VW close behind. The Model S held a commanding lead, stopping in Sandusky, Ohio, just 114 miles from the finish line. The Nissan Leaf spent the night back in Athens, less than halfway through the 1000 miles.

Life got easier as the teams reached Pittsburgh, having returned to the interstate, where fast-chargers are spaced at regular intervals. Our drivers were also becoming savvier. Several teams developed a fierce loyalty to the Electrify America network. Funded by Volkswagen as penance for selling and lying about dirty diesels, Electrify America has built more than 600 stations with 2600 plugs since 2017, and it's now the closest thing to a competitor to Tesla's fast-charger network. The company typically installs the equipment in banks of four to 10, which means there are options if units are broken or occupied.

But not for our teams in the Polestar 2 and Volvo XC40 Recharge. Electrify America equipment is made by four companies, and charging stations from one of them were incompatible with the Polestar and Volvo at the time of our drive. (Both automakers say software updates have since fixed the issue.) Deputy creative director Nathan Schroeder, piloting the 2, had been tipped off ahead of time, and he called EA's customer service to ask which units along the route would and wouldn't work. But something got lost in translation. Charging units that weren't supposed to work did, and those that were supposed to didn't, adding an element of chance to an equation that didn't need any more variables.

Teslas are generally immune to such nonsense. While Superchargers could be finicky in their early days, the current equipment is more dependable than a gas-pump credit-card reader. The network is also dense. The Model S once passed four Supercharger stations before stopping. It arrived back at the office after 16 hours and 14 minutes of driving and charging. Google Maps says this trip is just 50 minutes shorter without a single stop.

Carty and staff editor Austin Irwin pulled into their last charging stop after the Model 3, but they refused to accept third place. When the other team wasn't paying attention, they unplugged the Model Y and took off at a furious pace, beating the 3 back to the office to claim second.

Tesla's sweep of the podium makes it clear: If you want to regularly drive long distances in an EV today, you'll want a car with access to Tesla's proprietary charging infrastructure. The rest of the group trickled in over the next several hours, with the exception of the Leaf, which needed twice as long as the Tesla Model S to finish. With its short range and slow charging, the Nissan clearly wasn't intended to stray far from home.

Our drivers are split when asked whether the EV 1000 was harder or easier than expected, but most say that if they were to do the trip again, they would do one thing differently: drive a gas car. And that includes the Tesla drivers. We'll know that the charging networks and EV technology are fully baked when we're no longer saying that.

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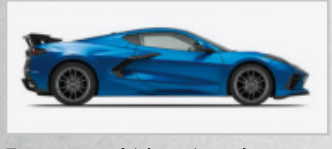

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UNPLUGGED

The future is electric, but the gas engine won't go quietly.

Did you hate everything you read on the last 66 pages? This section's for you.

The V-8 Fights Back

In a rural Massachusetts garage, Rich Benoit and his merry band of outlaws are jamming a 6.2-liter V-8 from a wrecked Camaro SS into a Tesla Model S.

Rich Benoit is learning to deal with the hate. What he's doing "goes against a lot of people's core beliefs," he says. "Their reaction is visceral."

Just for the hell of it, Benoit and his pals Steven Salowsky and Joshua Dodge are packing an LS V-8 into the least likely candidate for a Chevy small-block swap: a Tesla Model S. They call it the FrankenTesla or ICE-T (short for Internal Combustion Engine-Tesla) and are documenting the project on the YouTube channel Rich Rebuilds, which has 1.15 million subscribers.

Many of those viewers first tuned in years ago to follow along as Benoit restored totaled Teslas for a fraction of the cost of a new one. But now hate is coming hard and fast from Tesla's ardent fan base, which loudly objects to this very public desecration. To those who buy every word of Elon Musk's planet-saving rhetoric, a Model S powered by a V-8 engine is a fate worse than the crusher.

From top: The best use yet of a Tesla's frunk. The transmission tunnel and clutch pedal hint at things to come. Salowsky's flow oversees work on the wiring harness.

"IT'S A VERY GOOD EXPERIMENT. HOW WILL A CAR THAT WAS NOT DESIGNED TO HAVE A GAS ENGINE HANDLE IT? IS IT GOING TO FOLD LIKE A TACO THE SECOND YOU PUT IT ON A MAIN ROAD?"

—Rich Benoit

When the FrankenTesla project began, a lot of followers left, says Benoit, "but we gained tens of thousands more."

"It's unfortunate they don't see the point," says Salowsky, who, with his long hair, sandals, and head-cocked sense of wonder, is the garage philosopher-poet. "It's not just about the build."

"Yeah, it's about having fun," says Benoit.

Dodge, a welder-fabricator with some serious chops, gets credit for dreaming up the Tesla V-8 project. "I just wanted to put an LS in a Tesla to see if it could be done," he says. Despite having a résumé that includes NASCAR gigs, he doesn't toot his own horn. He would just as soon fade into the background and let his weld beads—long, meticulous runs—speak for themselves. Dodge fabricated custom subframes to carry the LS V-8 and rear differential and welded a tunnel the length of the Tesla's flat floor to make room for the transmission and driveshaft.

It's a serious build, although you might not realize the extent of the ambition given the laid-back, goofy, and irreverent attitude that carries through every video. When the crew fired the engine for the first time—using a five-gallon bucket as a temporary fuel tank—they underscored the magnitude of the moment with Apollo 11 countdown audio and clips of Musk marveling at the 2018 launch of his SpaceX Falcon Heavy rocket. Running rich and without exhaust manifolds, the 6.2-liter V-8 shot fireballs into the Tesla's engine bay as it rattled the garage and Dodge's house.

The team figures they're still months from actually driving the FrankenTesla, which is fine by them. They're enjoying themselves too much to be in a hurry.

—Neil Dunlop

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Forget Me Not

Highs: Fully loaded value, clever all-wheel-drive system, steering and brake feel. Lows: Small rear seat, ride harshness.

Acura keeps sending forget-me-nots. First came the second-gen NSX, a 573-hp mid-engine sign that the brand had been working on itself. It showed us that it had made some big changes and wanted to have a heart-to-heart about performance. Now the 2021 TLX Type S sports sedan has arrived at our doorstep, and its 355-hp V-6 and torque-vectoring all-wheel-drive system are the kind of wooing that totally works on us.

Not to be confused with the relatively mild-mannered TLX introduced last year, the Type S revives Acura's high-performance moniker. Set up for use on the street and not necessarily with track driving in mind, this car is priced to compete with models like the Audi S4 and BMW M340i—not Audi's more extreme RS models or BMW's M cars—but it's about the size of an A6 or a 5-series, making it bigger than the targeted competitors.

The 3.0-liter V-6 has strong acceleration and only a hint of low-rpm turbo lag as the engine reaches its max boost of 15.1 psi. We measured a 4.9-second time to 60 mph and a 13.6 quarter-mile at 103 mph. Acura's all-wheel-drive system puts the power down with zero fuss, and the 10-speed automatic flutters through the gears imperceptibly. A rush of torque at low rpm helps keep the transmission from having to hunt for lower gears on hilly freeways.

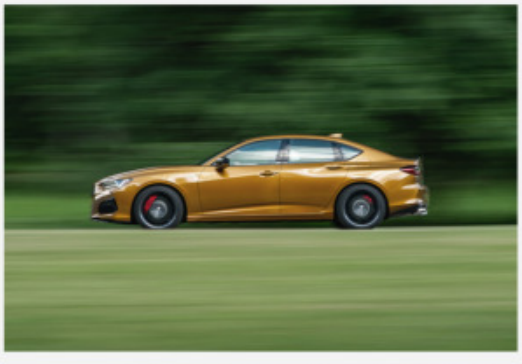
A few turns of the thick-rimmed steering wheel and it's obvious that the Type S is about more than going straight. Acura has returned to a control-arm front suspension, and there's a sweetness and liveliness to the steering and turn-in that helps shrink this

THE NUMBERS

Vehicle Type: front-engine, all-wheel-drive, 5-passenger, 4-door sedan
Base/As Tested ..... $53,325/$54,625
Engine: turbocharged and intercooled DOHC 24-valve V-6, aluminum block and heads, direct fuel injection
Displacement ..... 183 in³, 2997 cm³
Power ..... 355 hp @ 5500 rpm
Torque ..... 354 lb-ft @ 1400 rpm
Transmission: 10-speed automatic
Dimensions
- **Wheelbase** ..... 113.0 in
- **L/W/H** ..... 194.6/75.2/56.4 in
- **Curb Weight** ..... 4201 lb

TEST RESULTS

60 mph ..... 4.9 sec
100 mph ..... 12.6 sec
1/4-Mile ..... 13.6 sec @ 103 mph
130 mph ..... 24.2 sec
Results above omit 1-ft rollout of 0.3 sec.
Rolling Start, 5–60 mph ..... 5.5 sec
Top Speed (C/D est) ..... 155 mph
Braking, 70–0 mph ..... 165 ft
Braking, 100–0 mph ..... 359 ft
Roadholding, 300-ft Skidpad ..... 0.96 g
EPA Fuel Economy
- **Comb/City/Hwy** ..... 21/19/24 mpg



4201-pound sedan in the tight stuff. Opting for the $800 summer rubber scores you grippy Pirelli P Zeros on lightweight NSX-inspired wheels and 0.96 g of skidpad traction.

To counteract body motions, the Type S has 40 percent stiffer front springs than the regular TLX and larger anti-roll bars front and rear. The all-wheel-drive system can shake the tail, giving the car some attitude when you're hard on the throttle. Basically, just stomp the accelerator and the TLX does the hard math to turn your foot's request into speed.

Hitting the other pedal erases speed quickly and confidently, thanks to 14.3-inch front rotors and four-piston calipers. Stops from 70 require 165 feet, a few more than the brake feel suggests. An electrically powered brake booster is tuned to provide firmness with good bite, and while the lack of pedal travel takes some getting used to, after a few miles, we're adjusted and appreciative.

Turn the Dynamic Mode knob to Sport Plus and the adaptive dampers cinch up and react more quickly to input from accelerometers at each corner. This mode enhances the torque-vectoring differential's rear-steer effect, making the tail more eager to rotate, and gets the automatic to channel racer Alexander Rossi's brain as the transmission calls up the right gears under braking and fires off quick upshifts at the redline.

Dial back to Normal mode and a mellower Type S emerges. The active exhaust becomes less prone to fits of rage, and the steering effort relaxes while maintaining its tactility. But even in its softest setting, the TLX has a firm, sometimes harsh ride. The Type S transformation included stiffening the TLX's body, and the structure is certainly tight, but a showroom-fresh Audi S4—on hand for a Pepsi Challenge—displayed better suspension isolation and a tighter-feeling chassis.

Simple and elegant analog gauges might buck the glass-cockpit sports-sedan norm, but leather-and-microsuede seats, metal pedals and trim, and a stitched instrument panel are right in line with what competitors offer. Rear-seat riders get a supportive bench, but legroom and space back there are lacking despite the 113.0-inch wheelbase. Our test gear measured a calm 71 decibels reaching the driver's ear at highway speeds, although switching to Sport or Sport Plus mode increases the amount of V-6 sound pumped into the cabin.

The Type S starts at $53,325, and the options list consists of $500 paint and an $800 wheel-and-tire package. A stripper S4 can be had for less, but comparably equipped, the German competition is far more expensive. Cadillac's CT5-V also slides in under the Acura's base price, but again, with all-wheel drive and similar trimmings, it can't beat the Type S. We're most curious to see how the TLX stacks up against a fully loaded Genesis G70 3.3T, which undercuts it in price but also in size. If that sounds like an interesting comparison test, watch this space.

Acura calls this color Tiger Eye Pearl because—we're assuming here—it wants you to have the *Rocky III* theme stuck in your head for the rest of the day. And probably tomorrow. Sorry.

2022 MASERATI MC20 ~ BY GREG KABLE

Stepping out of the Shadows

Now free to build a supercar, Maserati shows its stuff.

Not many automakers have the audacity to take on Ferrari. But when your name is Maserati and you're looking to crown your lineup with a new 621-hp mid-engine supercar, you're not going to let a former partner—no matter how storied—stand in the way. The MC20 is the first mid-engine Maserati developed and produced in-house since the Bora and Merak in the early '70s. The coupe driven here comes first; an electric version and a convertible follow in a year or so.

In 1997, Maserati and Ferrari came together under Fiat, a move that curbed Maserati's supercar ambitions. They split in 2005, and while Maserati still uses Ferrari engines in various models as part of a long-running supply deal, corporate strategy in Modena now calls for complete engineering independence from Maranello. The two-seater MC20 effectively resets the Italian carmaker, which says it will use key parts of its mechanical package—including the new V-6 engine—in upcoming models as part of a broader rejuvenation of the brand. In addition to being the top Maserati model, the MC20 will also bring the company back to racing. Dallara, an Italian race-car manufacturer, collaborated with Maserati on developing the MC20.

The basis for the new car is a carbon-fiber tub, with aluminum substructures supporting the suspension and engine. The body is predominantly carbon fiber. Designed to accept both gasoline and electric powertrains, the MC20 is just over two inches longer than a Ferrari F8 Tributo. The gas MC20 should weigh about 3600 pounds in road spec.

The engine, known as Nettuno (Italian for Neptune), is fitted with dry-sump lubrication and patented prechamber ignition technology cribbed from Formula 1. The twin-turbocharged 3.0-liter V-6 boasts 621 horsepower and 538 pound-feet of torque. The eight-speed dual-clutch transaxle supplied by Tremec features a limited-slip differential as standard; an electronically controlled diff is optional.

A broad powerband allows the MC20 to chug along below 4000 rpm

THE NUMBERS

Vehicle Type: mid-engine, rear-wheel-drive, 2-passenger, 2-door coupe
Base (C/D est) **$213,000**
Engine: twin-turbocharged and intercooled DOHC 24-valve V-6, aluminum block and heads, port and direct fuel injection
Displacement ..... 183 in³, 2992 cm³
Power ..... 621 hp @ 7500 rpm
Torque ..... 538 lb-ft @ 3000 rpm
Transmission: 8-speed dual-clutch automatic
Dimensions
• **Wheelbase** ..... 106.3 in
• **L/W/H** ..... 183.8/77.4/48.1 in
• **Curb Weight** ..... 3600 lb
Performance (C/D est)
• **60 mph** ..... 2.8 sec
• **100 mph** ..... 5.9 sec
• **1/4-Mile** ..... 10.5 sec
• **Top Speed** ..... 202 mph
EPA Fuel Economy (C/D est)
• **Comb/City/Hwy** ..... 17/15/20 mpg

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— Mike Valentine

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in GT mode, where a heady torque curve provides easy thrust. But in Sport mode it'll happily chase the 8000-rpm redline in shorter gears. The prechamber ignition system seems to foster outstanding throttle response and great versatility across the rev range. The power delivery is linear, and as with the best engines, the harder you work it, the more determined it becomes. Sound rushes into the cabin without synthetic enhancement. The speed of the upshifts is excellent, whether on part throttle or under full load, but the dual-clutch gearbox doesn't always live up to the V-6's greatness, with an occasional clunky downshift.

We're expecting the MC20 to sprint to 60 mph in 2.8 seconds thanks in large part to launch control. Maserati says the top speed is 202 mph, and the engine's heroics, combined with huge levels of traction, ensure the acceleration doesn't let up until the speedometer needle is well into triple digits.

And the MC20 turns in to corners beautifully. The carbon-fiber structure provides a rigid base, and there is a finely honed feel to the chassis, which mates adaptive dampers to a control-arm setup in front and a multilink suspension in back. The ride is good—almost daily-driver good—provided the dampers are in their soft mode. The weighting of the electrically assisted steering is light. But it's also quick (2.2 turns lock to lock) and precise, allowing you to place the MC20 confidently at corner entry. It is a car most drivers could drive hard without real trepidation. Turn the stability control off and you can harmlessly send the rear sideways. The point of breakaway is well communicated, allowing you to unsettle the tail and then hold big slides on the throttle.

Strong brakes are part of the deal. Optional 15.4-inch front and 14.2-inch rear carbon-ceramic rotors are grabbed by six- and four-piston Brembo calipers, respectively. The brakes like to have some heat in them before they bite with proper intent, but when they do, they generate breathtaking stopping power.

Priced at an estimated $213,000, the MC20 takes aim at some heavy-hitting mid-engine rivals. Maserati hopes for annual sales to reach 1500, split between the roadgoing car we drove and the upcoming racing version. North American deliveries are expected later this year. The MC20 makes us wonder about all the supercars Maserati didn't build when it was in the shadow of the prancing horse. Now that it's unfettered by team orders, Maserati is poised to show what it can do.

Following the latest fashion, the MC20's steering wheel appears to have more switchgear than its dashboard. The mighty V-6 makes 207.6 horsepower per liter.

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2020 BMW M2 CS VS. 2021 PORSCHE 718 CAYMAN GTS 4.0 ~ BY TONY QUIROGA

If I Had a Hammer

BMW used every tool at its disposal to transform an M2 into a sports car. But is it as good as a Porsche Cayman?

If you've ever used a wrench in place of a hammer, you'll understand what the BMW M2 is about. Engineers took an aging upright compact coupe that normally rides on run-flat all-season tires and transformed it into a great-driving car. Not content with the new tool, BMW has continued to adapt this wrench into the M2 CS. The 3533-pound result nails corners. From its acceleration to the sounds coming from the CS's 444-hp engine, it has all the sports-car traits that make us warm and tingly. It is the product of clever improvisation and adaptation. But as strong as the M2 CS is, we wondered, can it do just as good a job as a hammer?

Porsche's 718 Cayman GTS 4.0—our hammer—starts out with the right stuff. It's a two-seat, mid-engine, 3231-pound smile machine. A sports car at its core, the GTS 4.0 version gets a 394-hp 4.0-liter flat-six that sings to a 7800-rpm redline. Think of it as a poor man's GT4, if the poor man had $88,150 or, should he want our sparsely optioned, dual-clutch-automatic-equipped test car, $94,200. The Porsche's base price surpasses the Bimmer's by $3555, but as for the test cars, our M2 CS, loaded with carbon-ceramic brakes and a dual-clutch transmission, has the higher outlay, at $96,545. No doubt you're wondering why this tête-à-tête isn't between the less expensive manual versions. We wanted it to be, but BMW had just shipped its three-pedal M2 CS out east, leaving us with only the automatic to deal with L.A. traffic.

Shifting for yourself is more engaging than letting the car swap gears, even if it is slower. But these aren't your father's auto-tragic transmissions. Porsche's and BMW's dual-clutch gearboxes shift faster than you

To create a car that can hang with the Cayman GTS 4.0, BMW put the M2 on a diet rich in carbon fiber and bolted in the 444-hp twin-turbocharged inline-six from the old M4 Competition.

The test numbers say these cars deliver similar experiences, but the differences are real on roads like this. The BMW is scrappy and playful; the Porsche is precise and poised.

can and have software astute enough to call up the same gears you would. For a closer connection, grab the steering-wheel paddles. Both models come with launch control, which makes lining up next to a challenger a little less stressful. Porsche's system revs the naturally aspirated six to 6600 rpm before perfectly slipping the fluid-bathed clutch to make the most of the traction from the Pirelli P Zero PZ4s. Do it as much as your inner 17-year-old desires. The GTS dutifully returns 3.4-second runs to 60; the manual version adds 0.4 to that.

BMW's max-acceleration programming isn't as effective. Try to launch at the default 3000 rpm and the twin-turbo 3.0-liter's low-end surge will light up the Michelin Pilot Sport Cup 2 tires as soon as the clutch plates make contact. BMW allows the driver to adjust the launch rpm by tapping the cruise-control toggle. The best practice on regular asphalt is to set it to the 1900-rpm minimum so the tires hook up before the boost arrives. We measured a 3.6-second run to 60—the six-speed does it in 3.9.

To see how well each of these cars can pound curves into submission, we headed north out of L.A. and onto Frazier Park's empty canyon roads. Jump from the Cayman to the M2 and

the BMW seems like a small SUV. But once you adjust to the upright windshield and high seating position, the M2's handling dazzles. Though the steering-wheel diameter is about an inch and a half too large, actual feel comes through the thick rim. The Cup 2s send barely attenuated jolts, jabs, and noise into the cabin, but the upside is steering feedback and precision and 1.05 g's of skidpad grip. Caught between the sticky track-spec rubber and the brawny 444-hp engine, the BMW's rear end squirms in distress under hard acceleration out of corners. That motion doesn't amount to much, but it moves through the seat and into your body. You get the impression that this little hellion is working hard for you. From the M2's logbook: "Playful, alive, and devilishly imperfect."

Inside the Cayman, a small thin-rimmed steering wheel and a butt-on-the-road seating position await. The Porsche's mise-en-scène—with the raked windshield, low roof, and front-and-center tachometer—reads sports car, and its dynamics live up to the look. The GTS has a better relationship with the laws of physics than the 302-pound-heavier CS. It changes direction with ease and boasts steering that responds to every fing of your fingers. Plus, the GTS nearly matches the M2 in skidpad grip despite wearing milder rubber.

Without turbochargers force-feeding its six cylinders, the Cayman doesn't overwhelm its rear end on corner exit quite as much as the M2 does, especially when the road rises over 5000 feet. While the Porsche lacks the BMW's turbo surge, the finely tuned throttle makes it seem possible to mete out each individual horse. That ability to precisely dial in the engine allows the driver to approach and ride the limit without fear of overburdening the chassis or the handling. Keep adding speed; no component appears unduly burdened.

Both cars feature adaptive dampers and steel springs that provide firm but livable ride quality, with a small comfort advantage going to the Cayman. Either will stop hard enough to dislodge any french fries hiding under the seats, yet the Porsche prevails with its 149-foot stop and the firmness and grab of its brakes. The intake chortles and screams of the flat-six are also something the M2 can't match. There's a raucousness to the BMW, but the Porsche brings you closer to the machinery, which is literally just a couple of inches behind you.

The Porsche is the better car in nearly every regard, a win earned by being exactly the right tool for the job. Still, the BMW wears its flaws in a way that draws you in. More endearing, sillier, and just a bit less under control than the Cayman, the M2 CS is the one you'll remember, the one that will inspire gesture-filled stories beginning with "There I was . . ." But while it may be possible, and even fun, to pound a nail with something like a pipe wrench, a hammer is really what you need.

	2020 BMW M2 CS	2021 Porsche 718 Cayman GTS 4.0
Base/As Tested	**$84,595**/$96,545	$88,150/**$94,200**
Dimensions		
Wheelbase	106.0 in	97.4 in
Length/Width/Height	175.6/73.7/55.7 in	173.4/70.9/50.2 in
Track, F/R	62.2/63.0 in	60.1/60.4 in
Passenger Volume, F/R	**52/37 ft³**	49/– ft³
Cargo Volume, F/R	–/**14 ft³**	**5**/10 ft³
Powertrain		
Engine	twin-turbocharged DOHC 24-valve inline-6 182 in³ (2979 cm³)	DOHC 24-valve flat-6 244 in³ (3996 cm³)
Power, hp @ rpm	**444** @ 6250	394 @ 7000
Torque, lb-ft @ rpm	**406** @ 2350	317 @ 5500
Redline/Fuel Cutoff	7600/7600 rpm	7800/7800 rpm
lb per hp	**8.0**	8.2
Driveline		
Transmission	7-speed dual-clutch automatic	7-speed dual-clutch automatic
Driven Wheels	rear	rear
TEST RESULTS		
Acceleration		
30 mph	1.5 sec	**1.3 sec**
60 mph	3.6 sec	**3.4 sec**
100 mph	8.0 sec	**7.9 sec**
1/4-Mile @ mph	11.8 sec @ **122**	**11.6 sec** @ 121
150 mph	20.0 sec *Results above omit 1-ft rollout of 0.2 sec.*	**19.8 sec** *Results above omit 1-ft rollout of 0.2 sec.*
Rolling Start, 5–60 mph	**3.9 sec**	4.2 sec
Top Gear, 30–50 mph	**2.2 sec**	2.5 sec
Top Gear, 50–70 mph	2.7 sec	**2.4 sec**
Top Speed	174 mph (mfr's claim)	**179 mph** (mfr's claim)
Chassis		
Braking, 70–0 mph	155 ft	**149 ft**
Roadholding, 300-ft Skidpad	**1.05 g**	1.04 g
Weight		
Curb	3533 lb	**3231 lb**
Distribution, F/R	52.3/47.7%	43.4/56.6%
Fuel		
Capacity/Octane	13.7 gal/91	**16.9 gal**/93
EPA Comb/City/Hwy	19/16/23 mpg	**21/19/24 mpg**
C/D 250-mi Trip	**20 mpg**	**20 mpg**
Sound Level		
Idle/Full Throttle	**45/87 dBa**	58/89 dBa
70-mph Cruise	**71 dBA**	73 dBA

2nd Place: BMW M2 CS
Plus **Power surges, real steering, delightful imperfection.** Minus **Harsher ride than the Porsche, tire roar, squirms under duress.**

1st Place: Porsche 718 Cayman GTS 4.0
Plus **A big flat-six where Newton would want it, capability to handle what you throw at it, a fully dialed-in experience.** Minus **Engine lacks the turbo punch of the BMW, just two seats.**

TESTED BY **TONY QUIROGA** IN CALIFORNIA CITY, CA

2021 JEEP WRANGLER
RUBICON 392 ~ BY EZRA DYER

Going Nuclear

Jeep builds a 470-hp Wrangler. Hilarity ensues.

Whatever kind of engine you want, the Jeep Wrangler offers it. Jeep's four-wheel-drive anachronism is available with a turbocharged four-cylinder, a naturally aspirated V-6 (with or without 48-volt hybrid assistance), a turbo-diesel V-6, and a turbo four with a plug-in-hybrid system. And now, rounding out Jeep's offer-all-the-engines policy is a gargantuan 470-hp 6.4-liter V-8. No, Jeep didn't use the supercharged Hellcat engine. Nobody has enough life insurance for that.

The Wrangler Rubicon 392 is Jeep's G63. A mud-bog Maserati. It's "Hold my beer" with an eye-level hood scoop. While everyone is fawning over the Ford Bronco, Jeep is clearing its throat through quad tailpipes and asking for your attention. You've seen the Wrangler, folks, but never like this.

Why did Jeep wait more than 30 years to build a V-8 Wrangler? Two reasons. First, until now, there was no impetus to go nuclear with underhood weaponry. You didn't need a V-8 to compete with the Suzuki Samurai back in the 1980s. In fact, for the past two decades, the Wrangler's biggest competition has been Jet Skis and divorces. The new Bronco is about to change that.

The second explanation pertains to the philosophical matter of fast Wranglers and whether such things violate the natural order of the world. A 6.4-liter Wrangler is a rocket-propelled basset hound, an unlimited-hydroplane tugboat, a 360-degree rotating rooftop restaurant set to 88 rpm. Have you seen those new speed stilts? No, because there's no such thing. And yet, Jeep makes this hoss.

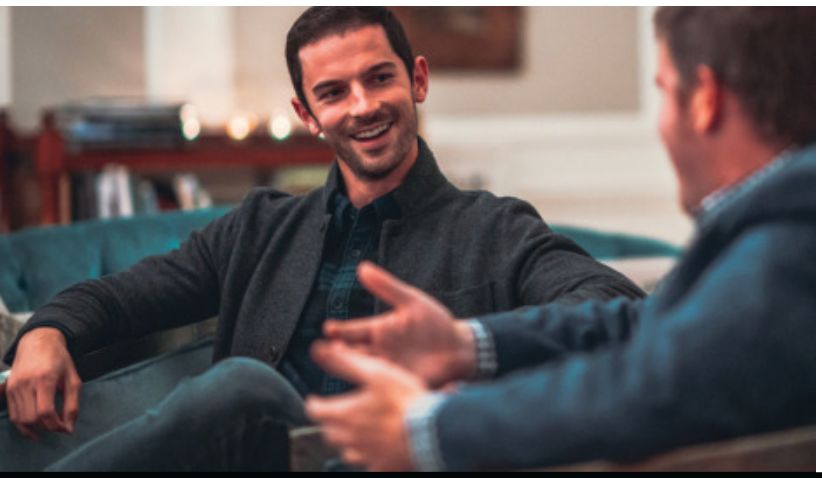
With 470 horsepower and 470 pound-feet of torque, the Wrangler 392 can hit 60 mph in 4.5 seconds, according to Jeep. The fun doesn't last much longer, though, as this is the rare sub-5.0-second-to-60-mph machine that can't hit 100.

THE NUMBERS

Vehicle Type: front-engine, 4-wheel-drive, 5-passenger, 4-door wagon
Base $74,995
Engine: pushrod 16-valve V-8, iron block and aluminum heads, port fuel injection
Displacement ..... 391 in³, 6410 cm³
Power ..... 470 hp @ 6000 rpm
Torque ..... 470 lb-ft @ 4300 rpm
Transmission: 8-speed automatic
Dimensions
• **Wheelbase** ..... 118.4 in
• **L/W/H** ..... 188.4/73.8/74.5 in
• **Curb Weight** ..... 5150 lb
Performance (*C/D* est)
• **60 mph** ..... 4.5 sec
• **1/4-Mile** ..... 13.0 sec
• **Top Speed** ..... 99 mph
EPA Fuel Economy
• **Comb/City/Hwy** ..... 14/13/17 mpg

Top speed is governed at 99 mph so as not to abuse the ute's Q-rated BFGoodrich All-Terrain T/A KO2 tires. The full-time four-wheel-drive system doesn't offer a two-wheel-drive mode—probably for the best since this rig can do four-wheel-drive burnouts if the pavement's even slightly damp. For launches that feel like they might involve a wheelstand, apply left-foot braking to cue up Torque Reserve, which

PHOTOGRAPHY BY BRIAN ROZAR ~ JULY/AUGUST 2021 ~ CAR AND DRIVER



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is basically launch control for dummies. A new button on the dash lets you choose between a loud exhaust and a Monster Jam Freestyle–loud exhaust.

While there's no 2Hi mode for the transfer case, there is low-range four-wheel drive, and the 392's Off-Road Plus driving mode allows you to lock the rear differential at high speeds, leading us to wonder what Jeep thinks people will try to do with this thing. Maybe the better question is, what won't they try to do? To accommodate the Hemi engine and the shenanigans it'll inspire, Jeep strengthened the 392's frame, fitted a two-inch suspension lift with Fox dampers, and upgraded the rear brakes. But there are only so many ways to cope with this much horsepower in a Wrangler. For instance, the 17-inch wheels can accept beadlock rings that firmly pinch the tire to the rim, a feature often associated with airing down tires for low-speed trail work. But as we discovered, when you're roosting sand dunes with 470 ponies, you might need beadlocks even with the tires fully aired up. When we took the Rubicon 392 to a local tire store to investigate a slow leak, the technicians wondered about the rubber-to-earth violence that got sand inside a mounted tire.

The V-8 doesn't leave room under the hood for much else, such as a supercharger. The Rubicon 392 may be as close as Jeep comes to building a Hellcat Wrangler.

All of this over-the-top performance comes with predictably hyperbolic pricing. The Wrangler Rubicon 392 starts at $74,995. Meanwhile, $55,000 will get you a plug-in-hybrid Wrangler Rubicon 4xe, which is eligible for a $7500 tax credit and also makes 470 pound-feet of torque. The combination of price and performance makes a lot of sense, which is why we doubt that audiences for the 4xe and 392 will overlap even a little bit. The 392 isn't about making sense. It's about making noise and stomping Broncos and not necessarily in that order.

While a V-8 Wrangler may seem obvious and inevitable, it's fortunate that Jeep accrued three decades of chassis development before unleashing one on the public. Still, the Rubicon 392 is a royal handful, a bellowing, muscle-bound clodhopper on 33-inch tires. If it's your dream Wrangler, thank Jeep for giving it the green light for production—right after you thank Ford for applying the pressure.

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ICE CREAM, TRAINS, AND TORQUE. WHAT WE IMAGINE THE 46TH PRESIDENT TOOK AWAY FROM HIS DRIVE OF A 2022 FORD F-150 LIGHTNING PROTOTYPE. BY "JOE BIDEN"

C'mon, man. This was, as even my friends on the other side of the aisle concede, always going to happen. Of course I'm going to sell my exclusive drive of the Ford F-150 Lightning to my favorite car magazine, the one you're holding in your hands right now. What's that? The kids don't read magazines? They don't know what they're missing. Now, I didn't land this Lightning exclusive because I personally knew Henry Ford. That's horsefeathers! I'm serious.

Look, folks, no one outside the Ford Motor Company has driven the electric F-150, and let me tell you, it's all about clean, good, green jobs, good American jobs building them. But it's also about the future.

Torque is the future. That's not hyperbole. By golly, it's got torque. A big 775 pound-feet worth. Let me tell you, when I hit the accelerator, this thing pulled harder than the Amtrak from Washington to Delaware. I nearly spilled the sarsaparilla I had in the cupholder! Get the big battery and it'll go 300 miles, which will make it possible to go from sea to shining sea if you can find a DC fast-charging hookup.

Let me tell you, the Lightning's torque is sweeter than chocolate-chocolate-chip ice cream in a sugar cone. That's my go-to. Good stuff, folks. Baskin-Robbins, Ben & Jerry's, or the Häagen-Daisy, Dazs. I have a freezer full of ice cream in the White House garage, right next to my '67 Vette. Gotta keep the things you love together.

Anyway, this electric F-150 is the future. No malarkey. And boy howdy, isn't she pretty? Square, bright, and built to last. There's no engine up front, so there's a space to bring home the latest from Admiral and RCA. It's the sort of space you have in the overhead bins on the train. Ford has more than 70,000 orders for this new truck. You know, it's always encouraging to see the young people caring about things and smiling about things and ordering things with their stimulus checks.

Infrastructure and great trucks like this one are one and the same. It reminds me of when I was growing up in the Electric City, Scranton, Pennsylvania, where I learned about hard work, and that's what it's going to take to rejuvenate our electrical grid, but that's what we're going to do. I just had a great idea. How about an electric ice-cream truck? That's coming, right? Of course it is. Because America can do anything.

We want a future where every American has a clean, American-made, nonpolluting pickup. And good roads and bridges to drive it on. It's about batteries too. Great American batteries that go into American machines like this 563-hp pickup. American lithium and American ions working together, coming together, doing that chemistry foxtrot. Were these batteries made in Delaware? Can someone look into that? Because the F-150 is really the right vehicle for the entire Delaware Valley, from Trenton to Philly and Wilmington. You can even power your house with it. When Old Man Winter sends a nor'easter that knocks out your Kelvinator, now your ice cream won't melt. That's safeguarding America.

This is literally bigger than politics. The Lightning is the kind of truck that will appeal to all Americans. Good, honest folks who keep me humble but always hopeful and, and . . . you know I see them at Mass every Sunday, and they tell me about their trucks. But now we've got a truck with batteries, a big-screen TV in the dashboard, and you'll get $7500 back when you buy one! Have we talked about Amtrak? Of course we have. But you know, it's important. It's vital. And there's nothing better than eating ice cream on Amtrak. Except maybe in an F-150 Lightning filled to capacity with 2000 pounds of ice-cream sandwiches. Weren't those invented in Pittsburgh? Someone check on that.

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